Chapter 4
Competitiveness

Chapter Contents

This chapter focuses on the performance and cost of each substitute blanket wash. Section 4.1 discusses the results of the performance demonstration of each blanket wash, both in a laboratory setting and in an actual print shop. All 37 blanket washes (including the baseline) were tested at the Graphic Arts Technical Foundation (GATF) laboratory for flash point, volatile organic compound (VOC) content, pH, blanket swell potential and wipability. Of the 36 formulations (plus the baseline) analyzed at GATF, 22 were field tested. Each of these 22 blanket washes was used at two print shops, and evaluated on factors such as how well the ink was cut and how quickly the blanket dried. The limitations of these field evaluations are briefly presented and the results discussed in greater detail. Section 4.2 presents the costs associated with using the 22 field tested blanket washes. For each of the two facilities where a blanket wash was tested, data on cost/wash, cost/press, and cost/press/shift/year were developed and compared with baseline costs using VM&P Naphtha. This section also contains a description of the different variables used to develop the cost data, such as labor costs, blanket wash costs, and other materials costs. Section 4.3 addresses international trade issues for blanket washes in general. Importation and exportation of both petroleum based blanket washes and low VOC blanket washes are discussed, as well as joint ventures between foreign companies.

4.1 PERFORMANCE DATA

4.1.1 Background

This section of the CTSA summarizes performance information collected during laboratory and production run performance demonstrations with substitute blanket washes carried out between November 1994 and January 1995. Performance data collected included information such as quantity of wash used, time spent to wash the blanket, ink coverage, and the effectiveness of the wash. Data from the performance demonstrations, in conjunction with risk, cost and other information presented in other sections of the CTSA, provides a more complete assessment of substitute blanket washes than has otherwise been available from one source.

In a joint and collaborative effort, EPA worked with the Printing Industries of America (PIA), the Graphic Arts Technical Foundation (GATF), and other industry representatives to organize and conduct the performance evaluations of 36 substitute blanket washes and the baseline. The

demonstration methodology was developed by consensus and was designed to allow the evaluation of the maximum number of blanket washes given the resources available to the project. Performance data were collected for each product in two distinct phases: 1) a laboratory test of the chemical and physical properties and the efficacy of the substitute products, and 2) evaluations conducted in a production setting at volunteer printing facilities. The intent of the laboratory evaluations was to independently measure some of the properties of the washes, such as volatile organic compound (VOC) content, and to assure that the blanket washes sent to volunteer printers would provide an acceptable level of performance. Facility demonstrations were undertaken at the request of printers participating in the DfE project so that blanket washes could be evaluated under the more variable conditions of production runs at printing facilities. It should be noted that the performance demonstrations are not rigorous scientific investigations. Instead, much of this chapter documents the printers' experiences with and opinions of these products as they were used in production at their facilities.

Participation in the demonstration project was open to all blanket wash manufacturers. Prior to the start of the demonstrations, the DfE project staff contacted nearly 100 blanket wash manufacturers to explain the project goals and request their submission of a product. All those who responded and submitted blanket washes were included in the first phase of the demonstrations.

4.1.2 Methodology

The performance evaluation methodology developed by the workgroup is described below and covers both the laboratory testing protocol and the on-site demonstrations methodology. In developing the methodology, the workgroup agreed that product names would be masked. Neither the volunteer printers nor the DfE observers knew the manufacturer of the products being evaluated. Trade names are not listed in this report, instead the blanket washes are referenced by a numerical code and a genericized chemical formulation. This agreement to mask product names was made for several reasons:

- The chemical formulations of commercial products containing distinct chemicals are frequently considered proprietary. Manufacturers of these products typically prefer not to reveal their chemical formulations because a competitor can potentially use the disclosed formulation to sell the product, often at a lower price, since the competitor did not have to invest in research and development.

- The performance of products may vary depending on use and shop conditions, and suppliers were concerned about the characterization of the performance of their products.

- The EPA was concerned about appearing to endorse brand name products that fared well in the CTSA evaluation.

In the initial stages of the Lithography Project the Project partners chose VM&P Naphtha as the baseline against which to compare the 36 substitute blanket washes. VM&P Naphtha, composed of 100% solvent naphtha, light aliphatic and referred to as formulation 28 in certain sections of the text, was chosen primarily because it is well known among lithographers as an effective blanket wash. Many lithographers have used VM&P in their shops and know how it works in their applications and what it costs. VM&P is known to be highly effective at very low cost, however, because of its high VOC content (100%) printers are searching for formulations to replace it.

As the Performance Demonstration was being conducted, some suppliers who had submitted blanket washes chose to withdraw. Their reasons included not wishing to reveal to EPA their complete formulations or concern over the potential results of the performance tests. The

formulations that were withdrawn after work had already begun were numbers 2, 13, and 15. For this reason, those numbers are missing from all the tables in the CTSA.

Laboratory Evaluations

Laboratory testing was carried out by GATF in Pittsburgh, Pennsylvania. A total of 36 products were submitted plus the baseline. For each wash, the flash point, VOC content, and pH were tested. The vapor pressure of the product was not tested, but was submitted by the supplier. Two additional tests, a blanket swell test and a wipability test, were conducted to determine the efficacy of each wash prior to sending it out for field demonstrations. Only products that passed this functional demonstration stage were used in the field demonstration portion of the project. For both of these tests, GATF followed the manufacturer's instructions for diluting or mixing the product.

The blanket swelling potential of each product was tested to determine the effect of the wash on the blankets. The procedure used (detailed in Appendix C) involved measuring the thickness of the blanket test square (2 x 2 inches), maintaining contact between the test square and the wash for one hour, and taking another thickness measurement to calculate the percent swell. Another measurement is taken after 5 hours. Any wash where the blanket swell exceeded 3 percent after 5 hours indicated that the wash may dimensionally distort the blanket and was eliminated from field demonstrations.

Washability of each blanket wash was evaluated using both a wet and a dry ink film (detailed in Appendix C). To measure the washability, a standard volume of ink was evenly applied to a section of a new, clean test blanket. A measured volume of the wash was applied to a cleaning pad. The pad was attached to a mechanized scrubber and the number of strokes required to remove the wet ink were recorded. The procedure was repeated for a dry ink film where the ink was dried with a blow dryer for 20 minutes prior to the cleaning. The dry ink and wet ink tests were repeated for each alternative blanket wash submitted. Any wash where more than 100 strokes were required to clean the blanket (with cleanliness determined by using a reflective densitometer) was eliminated from the field demonstrations.

Based on the results of the blanket swell and the washability tests, 22 of the original 36 products submitted (plus the baseline) qualified for further evaluation through field demonstrations. Prior to shipping substitute blanket washes to printers for these on-site evaluations, each wash was repackaged into a generic container so that those printers demonstrating the products did not know the manufacturer or product name. Masked Material Safety Data Sheets (MSDSs) were also developed and shipped along with the substitute blanket washes to be evaluated.

Printing Facility Demonstrations

PIA affiliates recruited printers located in the Boston, Baltimore, and Washington, D.C. areas, who volunteered their facilities and their time to conduct the field demonstrations of the substitute products. A total of 17 facilities participated. Each substitute product was demonstrated at two facilities and each facility demonstrated a minimum of two and up to five different blanket washes. The product brand name was replaced with a blanket wash number so that the demonstration facilities did not know what product they were using. In addition, the facility names have been replaced with a facility number. A list of participating facilities appears at the front of this document.

To start the on-site demonstration, an "observer" from the DfE project visited each of the volunteer facilities. DfE observers were not EPA employees, but were drawn from staff of the contractor, Abt Associates Inc. The observers called each facility to review the details of their operation, discuss the goals of the project, and to schedule a site visit. The substitute products,

a baseline product, MSDSs, application instructions, and a measuring device were shipped to each facility prior to the DfE observer's arrival.

During each one-day site visit, the observer collected information on the background of the facility, as well as data specific to blanket wash performance. Background data included information on the size of the presses, the number of employees, and current blanket washing practices. After collecting the initial background data, the observers documented information on three types of blanket washes: the blanket wash currently used at the facility, a baseline blanket wash, and the substitute wash. All information was recorded on an Observer's Evaluation Sheet (see Appendix D). Starting with their standard wash, the press operator cleaned the blanket while the observer recorded the quantity of wash used, the time required to clean the blanket, the length of the run, the type and color of the ink on the blanket, and the number of wipes used. After restarting the press, the press operator was asked to comment on the effectiveness of the blanket wash and to determine if there were any changes in subsequent print quality that could be attributed to the blanket wash. This procedure was then repeated using Blanket Wash 28, VM&P Naphtha, the selected baseline. Naphtha was used at all participating facilities. By comparing the differences in the performance of the baseline at the two different facilities, any significant effects of facility-specific operating conditions (e.g., the type of ink, size of blanket, and operator's effort) on the performance of the substitute wash were more apparent. After cleaning the blanket with the baseline wash, the press operator then used the substitute wash provided. The observer recorded the same type of information as was recorded for both the current wash and the baseline wash. The total number of washes required varied from one facility to the next, since the observer was on-site for one day and recorded information on as many washes as were required during production that day.

After the observer's visit, the facility continued to use the substitute wash for one week. During the week, the printer at each volunteer print shop was asked to record information on product performance. The data recorded were similar to that collected by the on-site observer. However, the Printer's Evaluation Sheets (Appendix D) were simplified in an effort to minimize volunteer printers' burden and production disruptions. Facility background information such as the press size and type of shop towel used were recorded by the observer only. At the end of the week, the observer interviewed the press operator to obtain an overall opinion of the product. The exit interview information was recorded on another standardized form (Appendix D).

4.1.3 Data Collection, Summary and Analysis

The information summarized in the following section comes from five sources.

- Laboratory results: the chemical characteristics and the results of the blanket swell and washability tests were reported for each wash.

- Facility background information: the observer collected information on operating conditions while on-site at each volunteer print shop.

- Observer's data: DfE observers recorded information on the performance of the facility's current blanket wash, a baseline wash, and the substitute blanket wash.

- Printer's data: press operators recorded performance data for each blanket wash completed during the week-long demonstration of the substitute blanket wash.

- Follow-up interviews: observers interviewed the press operators at the end of the week-long demonstration on their overall opinion of the substitute blanket wash.

For each of the 22 substitute blanket washes in the field demonstrations, data from the sources mentioned above were analyzed and are summarized in this section. The experiences of the two facilities who demonstrated each product are presented individually. As part of the

analysis, a number of correlations were attempted for each facility but the results were typically not statistically significant due to small sample size. These analyses were run to determine if variations in the printer's opinion of the effectiveness of the blanket depended on any other variables such as ink coverage, effort and time spent on blanket washing, or run length. Where appropriate, these results are included within the following text summaries of each substitute blanket wash. Additionally, some summary statistics, such as average amount of product used, are presented in accompanying tables (Table 4-1).

4.1.4 Limitations

The widely variable conditions between and within printing facilities, the limited number of facilities, and the short duration of the performance demonstrations does not allow the results to be interpreted as definitive performance testing of the blanket washes. In addition, some facilities did not provide the full complement of evaluation forms because they found the performance of the substitute wash to be unacceptable and they discontinued use before the end of the week.

As mentioned previously, the performance demonstrations are not scientifically rigorous but are subjective assessments which reflect the conditions and experience of two individual print shops. There are a number of reasons why the results of performance demonstrations for any given blanket wash may differ from one facility to another. Among these reasons are:

- Variability in operating conditions. Because performance demonstrations were carried out during production runs, many factors which affect the performance of the blanket washes were not controlled during the evaluations including: ink type, ink coverage, condition of the blanket, the length of the run prior to blanket cleaning, and the ambient conditions such as temperature, humidity, and ventilation.

- Variability of print jobs. Different types of jobs had different requirements for blanket cleanliness. Observers noticed that what one facility considers to be a clean blanket another facility may find unacceptable.

- Variability of staff involved in performance demonstrations. Press operators' attitudes towards alternative blanket washes differ from one operator to the next and can affect their perception of performance. As previously mentioned, some of the information recorded was subjective and varied depending on a variety of factors including the attitude, perception, and previous experiences of the operator. For example, many of the substitute products were low in VOC content and did not evaporate as quickly as some of the more traditional blanket washes. Often, an extra step was needed to wipe the blanket with a dry rag to remove a residue left by some of the substitute washes. While extra cleaning steps can be time consuming and lead to increased production costs, even a minimal extra effort was regarded as an unacceptable burden by some operators. Other operators understood that some changes in their procedures and even some extra effort may be needed in order to effectively clean the blanket with an alternative product.

- Variability in application method. Press operators' overall opinion of the blanket wash could have been affected by their current application method. For example, operators who are accustomed to using high solvent blanket washes where little effort is required may differ in their opinion of "moderate effort" from operators who are currently using an alternative where some extra effort is already required. All manufacturers were asked to supply application procedures for their product. When instructions were supplied, the observer reviewed the procedures with the press operators, verified the correct procedure was used when the observer was on-site, and asked in the interview at the end of the week

Table 4-1. Blanket Wash Laboratory Test Results

Form. No.	Flash Point (°F)	VOC Content[1] (lbs/gal; % by weight)	pH	Blkt Swell		Wet Ink Film				Dry Ink Film			
				1 hr (%)	5 hr (%)	Blanket Density	Ink Density	Blanket Cleaned	Strokes	Blanket Density	Ink Density	Blanket Cleaned	Strokes
1	230+	2.3; 30%	7.8*	1.5	3.0	1.32	1.66	1.38	4	1.32	1.47	1.34	6
3	114	6.4; 91%	3.4*	1.5	4.5	1.33	1.76	1.34	4	1.32	1.49	1.34	4
4	114	6.4; 89%	8.7	3.0	5.2	1.32	1.85	1.33	3	1.32	1.47	1.36	2
5	139	2.5; 30%	4.3	6.1	15.4	1.31	1.79	1.33	9	1.33	1.49	1.37	8
6	152	3.5; 47%	5.5	0.7	1.5	1.32	1.81	1.34	8	1.33	1.52	1.35	6
7	165	3.0; 36%	9.3	3.8	6.8	1.27	1.73	1.36	6	1.31	1.51	1.36	8
8	115	3.3; 41%	4.0	7.7	20	1.32	1.79	1.34	7	1.33	1.47	1.34	9
9	230+	0.77; 10%	4.6	1.5	1.5	1.33	1.74	1.36	19	1.32	1.52	1.44	30
10	230+	0.16; 2%	5.7	0.7	0.7	1.28	1.78	1.42	12	1.28	1.47	1.29	13
11	150	4.3; 61%	5.0*	0.0	1.5	1.32	1.66	1.41	4	1.32	1.46	1.35	5
12	125	1.3; 20%	8.2	0.0	1.5	1.33	1.79	1.36	7	1.32	1.47	1.31	11
14	230+	0.97; 12%	5.0	1.5	3.0	1.28	1.79	1.31	8	1.29	1.51	1.32	10
16	145	7.2; 99%	9.8	4.5	10.6	1.25	1.64	1.30	2	1.30	1.51	1.34	2
17	220+	0.051; 0.6%	9.8	1.5	1.5	1.27	1.62	1.54	100	1.32	1.48	1.48	100
18	150	4.4; 60%	5.5	1.5	4.5	1.32	1.71	1.36	8	1.32	1.55	1.36	7
19	230+	1.8; 22%	4.6	1.5	1.5	1.28	1.79	1.33	11	1.27	1.45	1.30	9
20	170	2.7; 35%	7.1	0.0	1.5	1.30	1.77	1.34	5	1.29	1.52	1.34	7
21	115	3.5; 47%	6.2	0.0	1.5	1.32	1.56	1.41	7	1.31	1.43	1.42	6

Form. No.	Flash Point (°F)	VOC Content[1] (lbs/gal; % by weight)	pH	Blkt Swell		Wet Ink Film				Dry Ink Film			
				1 hr (%)	5 hr (%)	Blanket Density	Ink Density	Blanket Cleaned	Strokes	Blanket Density	Ink Density	Blanket Cleaned	Strokes
22	157(a)	NM; 2.17%	7.4(b)	1.5	[2]1.5	1.28	1.67	1.37	13	1.28	1.48	1.41	13
23	140	0.48; 6%	9.2	0.0	1.5	1.28	1.76	1.31	24	1.28	1.51	1.33	100
24	100	1.5; 19%	9.9	1.5	3.0	1.32	1.77	1.34	15	1.31	1.45	1.34	12
25	220+	4.1; 55%	4.3	3.0	4.5	1.27	1.73	1.36	22	1.33	1.53	1.49	32
26	230+	1.3; 18%	7.8*	0.0	0.0	1.28	1.73	1.33	6	1.32	1.48	1.40	14
27	145	7.2; 93%	3.9	3.0	4.5	1.27	1.67	1.30	3	1.33	1.55	1.35	3
28	50	6.2; 100%	6.6	1.5	3.0	1.33	1.80	1.32	3	1.33	1.51	1.33	8
29	230+	2.1; 30%	7.2	1.5	1.5	1.32	1.74	1.41	9	1.32	1.47	1.39	18
30	100(a)	0.48; 7%	7.6(b)	0.7	1.5	1.29	1.66	1.29	5	1.27	1.50	1.24	11
31	105	6.6; 99%	7.6	1.5	3.0	1.32	1.78	1.31	3	1.32	1.51	1.34	3
32	220	6.5; 99%	8.5	0.1	1.5	1.27	1.71	1.33	5	1.29	1.45	1.40	30
33	105	3.4; 46%	7.2*	4.5	7.6	1.27	1.77	1.28	4	1.31	1.45	1.35	4
34	138	2.8; 39%	6.6	1.5	3.0	1.32	1.79	1.35	10	1.32	1.49	1.35	20
35	105	6.7; 99%	6.0	1.5	6.1	1.32	1.76	1.35	3	1.33	1.46	1.34	5
36	175	3.5; 48%	5.7*	0.7	1.5	1.33	1.78	1.38	4	1.33	1.48	1.37	5
37	82	1.0; 14%	3.9	3.0	3.0	1.33	1.85	1.34	5	1.33	1.49	1.34	8
38	230+	4.9; 65%	5.6	0.0	1.5	1.32	1.76	1.43	9	1.32	1.48	1.37	16
39	155	2.9; 37%	9.2	1.5	3.0	1.29	1.73	1.31	7	1.31	1.50	1.34	10
40	155	3.8; 52%	4.8	1.5	3.0	1.33	1.81	1.39	5	1.33	1.51	1.35	10

(a) full strength (b) 25% NM - not measured * pH fluctuates wildly and may not be valid

[1]VOC content in lbs/gal was measured at GATF; % by weight VOC was calculated based on information submitted by the manufacturer.
[2]VOC content in lbs/gal was not measurable; % by weight VOC was submitted by the manufacturer.

if the application procedures had been modified in any way. If any changes were made, the type of change and the reason for the change are described in the performance summary.

- *Short term nature of the demonstrations.* Printers used the substitute blanket washes in their facilities for one week. Any long term effects such as premature blanket wear or corrosion would not have been apparent.

4.1.5 Blanket Wash Summaries

A summary of the performance of each of the 22 substitute blanket washes follows. Since the trade names of the substitute blanket washes are not given in this document, each blanket wash is identified by a numerical code and a generic chemical formulation. The specific types of chemicals that make up each of the generic formulations are explained in greater detail in Chapter 2. In addition, the facility names have been replaced with a facility number.

Performance of each product is presented separately for the two facilities, and includes a description of the facility's current blanket wash, their past experience in testing alternative blanket washes, their overall opinion of the substitute wash performance, and, if applicable, a summary of the factors that may have influenced performance. A table is also included for each blanket wash which presents the results of the laboratory test of both the substitute blanket wash and the baseline wash. Averages of the volume of wash used, time required, and effort required, as recorded by the printers during field demonstrations are also included in each product performance table. In addition, a summary table is provided that consolidates the results from all products into a single table (Table 4-2).

Table 4-2. Summary of Blanket Wash Performance Demonstrations

	Laboratory Results		Field Demonstration Results	
Product/ Facility	**VOC Content** (lbs/gal; % by wt)	**Flash-point** (°F)	**Avg Volume Used** (ounces)	**Performance Evaluation**
WASH 1				
Facility 3	2.3; 30%	230+	1.1 ± 0.2 [1.0][a]	Based on a sample size of 10 blanket washes: • Good performance for light or medium ink coverage. • Poor performance for heavy ink coverage; the extra time and effort needed were unacceptable. • Left a slight residue that was removed with a dry rag.
Facility 6			1.5 ± 0.6 [1.5][a]	Based on a sample size of 4 blanket washes: • Poor performance. • Print quality problems: image of the previous job was showing.
WASH 6				
Facility 11	3.5; 47%	152	1.0 ± 0.2 [0.7 ± 0.2][a]	Based on a sample size of 11 blanket washes: • Wash left oily residue that interfered with print quality. • Did not readily absorb into rag due to thick consistency; created delays. • Fair performance overall; more effort required with heavy ink coverage.
Facility 15			0.9 ± 0.2 [1.5 ± 0.7][a]	Based on a sample size of 23 blanket washes: • Cut ink well. • Did not readily absorb into rag due to thick consistency; created delays and effort necessary to clean was rated "high." • Did not leave a residue on the blanket.
WASH 9				
Facility 10	0.77; 10%	230+	3.1 ± 0.3 [1.5][a]	Based on a sample size of 4 blanket washes: • Poor performance. • Did not cut ink well, required excessive effort, and did not soak into rag. • Discontinued use of Wash 9 after 4 washes.
Facility 15			0.7 ± 0.1 [1.5 ± 0.7][a]	Based on a sample size of 21 blanket washes: • Poor performance. • Did not soak into the rag. • Required much more effort than the baseline.
WASH 10				
Facility 3	0.16; 2%	230+	1.0 ± 0.0 [1.0][a]	Based on a sample size of 4 blanket washes: • Printer declined to test product due to level of effort required to clean blanket. • Did not absorb well into rag. • Did not cut ink well.
Facility 4			3.0 ± 0.0 [3.0 ± 0.0][a]	Based on a sample size of 4 blanket washes: • Printer declined to test product due to level of effort required to clean blanket. • Did not absorb well into rag. • Did not cut ink well.

	Laboratory Results		Field Demonstration Results	
Product/ Facility	**VOC Content** (lbs/gal; % by wt)	**Flash-point** (°F)	**Avg Volume Used** (ounces)	**Performance Evaluation**
WASH 11				
Facility 1	4.3; 61%	150	2.5 ± 0.6 [2.5 ± 0.0][a]	Based on a sample size of 26 blanket washes: • Good performance for light/medium coverage. • Poor performance for heavy ink coverage; extra time and effort were needed. • Left slight, oily residue on blanket, but it did not affect the print quality.
Facility 2			1.5 ± 1.5 [1.2 ± 0.8]	Based on a sample size of 31 blanket washes: • Good/Fair performance for light/medium cover. • Poor performance for heavy ink coverage; extra product, time and effort were required. • Left slight, oily residue on blanket, but it did not affect the print quality.
WASH 12				
Facility 12	1.3; 20%	125	5.4 ± 0.8 [4.4 ± 1.6]	Based on a sample size of 16 blanket washes: • Was considered equal to baseline wash in overall performance. • Had difficulty cutting paper residue. • Wash was diluted 50% with water.
Facility 13			1.8 ± 0.4 [2.1 ± 0.5]	Based on a sample size of 19 blanket washes: • When not diluted with water, performance surpassed baseline and standard washes. • Averaged over all dilution levels, required slightly less effort than baseline wash. • Overall fair performance rating across ink coverages and dilutions.
WASH 14				
Facility 6	0.97; 12%	230+	1.3 ± 0.6 [1.5]	Based on a sample size of 15 blanket washes: • Good performance; cut ink well. • Extra effort was required to remove the oily residue that the wash left on the blanket.
Facility 16			2.8 ± 0.5 [2.0 ± 0.0]	Based on a sample size of 34 blanket washes: • Did not cut ink as well as the baseline wash. • Black inks and heavy ink build up are especially difficult to clean. • Thick consistency of the wash made it difficult to soak into rag.

	Laboratory Results		Field Demonstration Results	
Product/ Facility	**VOC Content** (lbs/gal; % by wt)	**Flash-point** (°F)	**Avg Volume Used** (ounces)	**Performance Evaluation**
WASH 19				
Facility 18	1.8; 22%	230+	4.8 ± 3.0 [1.5 ± 0.8][a]	Based on a sample size of 5 blanket washes: • Thick consistency of wash made it difficult to soak into rag and resulted in uneven application. • Large quantities were required to cut ink.
Facility 19			2.2 ± 0.5 [0.9 ± 0.2]	Based on a sample size of 8 blanket washes: • Thick consistency of wash was messy and difficult to use. • Cut demonstration short due to extra effort and time required to clean blanket.
WASH 20				
Facility 11	2.7; 35%	170	1.4± 0.6 [0.7± 0.2]	Based on a sample size of 17 blanket washes: • Performance considered fair, but worse than facility and baseline washes. • Left oily residue on blanket that required additional rotations to remove. • Hard to apply to rags due to thick consistency.
Facility 12			3.0 [4.4± 1.6]	Based on a sample size of 1 blanket washes: • Product induced nausea in press operators; Facility declined opportunity to test product.
WASH 21				
Facility 6	3.5; 47%	115	2.0 ± 0.6 [1.5]	Based on a sample size of 6 blanket washes: • Fair performance. • Cut ink well, but oily residue was difficult to remove. • Extra waste sheets required to get back up to color because of residue.
Facility 17			1.6 ± 0.4 [1.5 ± 0.4]	Based on a sample size of 25 blanket washes: • Fair performance. • Oily residue caused print problems if it was not completely removed. • Wash did not absorb into rag easily.
WASH 22				
Facility 12	Not measurable; 2.17%[b]	157	4.4 ± 0.6 [4.4 ± 1.6]	Based on a sample size of 5 blanket washes: • Cut ink as well as baseline wash. • Did not readily soak into rag, creating delays. • Fair performer overall.
Facility 13			3.4 ± 1.7 [2.1 ± 0.5]	Based on a sample size of 17 blanket washes: • Difficult to apply to rag due to thick consistency. • Left blanket slightly streaked and wet, extra drying time necessary to prevent print quality problems. • Cut ink as well as baseline wash, but required greater effort; a fair performer.

	Laboratory Results		Field Demonstration Results	
Product/ Facility	**VOC Content** (lbs/gal; % by wt)	**Flash-point** (°F)	**Avg Volume Used** (ounces)	**Performance Evaluation**
WASH 24				
Facility 16	1.5; 19%	100	2.2 ± 0.6 [2.0 ± 0.0]	Based on a sample size of 28 blanket washes: • Cut ink well, but some extra effort was required to wipe off oily residue. • Oily residue significantly increased the number of copies required to return to print quality.
Facility 17			1.3 ± 0.6 [1.5 ± 0.4]	Based on a sample size of 4 blanket washes: • Cut ink well. • Extra effort to wipe off oily residue. • Thick consistency of wash caused operator to curtail use. • Citrus odor was very strong to operator.
WASH 26				
Facility 5	1.3; 18%	230+	0.5± 0.1 [1.0]	Based on a sample size of 14 blanket washes: • Good performance rating after every wash. • Performed as well as both standard facility wash and baseline wash. • Slight oily residue caused print quality problems when wash was used for roller clean-up.
Facility 15			0.7± 0.1 [1.5± 0.7]	Based on a sample size of 22 blanket washes: • Good performance rating after every wash. • Performed as well as standard facility wash and baseline wash.
WASH 29				
Facility 7	2.1; 30%	230+	1.0 ± 0.0 [1.2 ± 0.0]	Based on a sample size of 3 blanket washes: • Good performance; cut ink well. • Extra effort was required to dry the blanket.
Facility 8			0.8 ± 0.6 [0.7 ± 0.0]	Based on a sample size of 36 blanket washes: • Did not cut ink as well as baseline wash. • Did not cut paper dust or powder. • More effort was required to remove slight oily film on blanket.
WASH 30				
Facility 18	0.48; 7%	100	4.0 ± 0.0 [1.5 ± 0.8]	Based on a sample size of 3 blanket washes: • Good performance; cut ink well. • Worked best with no dilution with water.
Facility 19			0.7 ± 0.0 [0.9 ± 0.2]	Based on a sample size of 8 blanket washes: • Cut ink well. • Required extra effort to dry oily film from blanket. • Thick consistency was difficult to use. • Extra effort was required due to resistance to surface of the blanket.

	Laboratory Results		Field Demonstration Results	
Product/ Facility	**VOC Content** (lbs/gal; % by wt)	**Flash-point** (°F)	**Avg Volume Used** (ounces)	**Performance Evaluation**
WASH 31				
Facility 7	6.6; 99%	105	1.5 ± 0.6 [1.2 ± 0.0][a]	Based on a sample size of 4 blanket washes: • Cut the ink well; slightly more effort needed to remove oily residue on blanket. • Oily residue slightly increased the copies required to return to print quality. • Smell not as strong as facility's standard wash or baseline wash.
Facility 8			1.1 ± 1.5 [0.7 ± 0.0]	Based on a sample size of 61 blanket washes: • Good performance; cut ink well • Performed as well as standard wash. • Slightly more effort was required due to resistance to surface of the blanket.
WASH 32				
Facility 1	6.5; 99%	220	2.5 ± 0.0 [2.5 ± 0.0]	Based on a sample size of 4 blanket washes: • Good performance. • Required slightly higher effort to remove excess wash than with the standard wash.
Facility 5			0.7 ± 0.2 [1.0]	Based on a sample size of 12 blanket washes: • Good performance. • Left slight, oily residue that was removed with dry rags and did not affect print quality.
WASH 34				
Facility 1	2.8; 39%	138	2.5 ± 0.0 [2.5 ± 0.0]	Based on a sample size of 37 blanket washes: • Good performance; best of the 5 substitute washes demonstrated at this facility. • Cut the ink well with the same effort as with the standard wash for light/medium ink coverage. • Slightly more effort needed for heavy ink coverage, but acceptable.
Facility 19			1.2 ± 0.4 [0.9 ± 0.2]	Based on a sample size of 13 blanket washes: • Fair/Poor performance. • Cut the ink well, but did not soak into rag and extra effort was needed to remove the oily residue.
WASH 37				
Facility 3	1.0; 14%	82	1.3 ± 0.6 [1.0]	Based on a sample size of 17 blanket washes: • Longer drying time than baseline and standard facility washes. • Performance rated as good and fair on light and medium coverages, respectively. • Press operators had no problems with wash.
Facility 4			2.2 ± 0.8 [3.0 ± 0.0]	Based on a sample size of 6 blanket washes: • Worked well initially, but caused paper breakup due to blanket tackiness. • Use of wash discontinued.

	Laboratory Results		Field Demonstration Results	
Product/ Facility	**VOC Content** (lbs/gal; % by wt)	**Flash-point** (°F)	**Avg Volume Used** (ounces)	**Performance Evaluation**
WASH 38				
Facility 2	4.9; 65%	230+	2.2 ± 0.6 [1.2 ± 0.8][a]	Based on a sample size of 9 blanket washes: • Oily residue caused print quality problems. • Use of wash discontinued after 1.5 days due to poor performance and print quality problems.
Facility 4			3.7 ± 1.3 [3.0 ± 0.0]	Based on a sample size of 6 blanket washes: • Use of wash discontinued after 6 trials due to print quality problems from oily residue. • Wash cut ink satisfactorily.
WASH 39				
Facility 5	2.9; 37%	155	0.7 ± 0.3 [1.0]	Based on a sample size of 32 blanket washes: • Good overall performance; cut ink well. • Did not dry as quickly as baseline wash and left an oily residue on the blanket. • Product did not work on rollers.
Facility 8			1.0 ± 0.0 [0.7 ± 0.0]	Based on a sample size of 5 blanket washes: • Did not cut ink well and therefore required extra time and effort to clean blankets. • Difficult to get wash to soak into rag. • Left oily residue on blanket.
WASH 40				
Facility 1	3.8; 52%	155	2.5 ± 0.0 [2.5 ± 0.0]	Based on a sample size of 6 blanket washes: • Good performance. • When diluted with water, left residue. No residue problem at full strength.
Facility 10			0.9 ± 0.2 [1.5 ± 0.0]	Based on a sample size of 20 blanket washes: • Good performance; cut ink well. • Required slightly more effort when coverage was heavy.

[a] Bracketed values ([]) are the results using the baseline wash (VM&P Naphtha) to clean the same blanket as was used in the demo at this facility.
[b] VOC content not measurable; % by weight VOC content was reported by manufacturer.

Blanket Wash 1

Composition:
Fatty acid derivatives
Alkoxylated alcohols

VOC Content: 30%; 2.3 lbs/gal
Flashpoint: 230+°F
pH: 7.8 (fluctuates wildly)

Facility 3

Facility 3 used Wash 1 for one week on a two-unit, 18" x 25" press. During the demonstration week, the facility used conventional inks to print letterhead and brochures. The standard blanket wash at Facility 3 contains aliphatic hydrocarbons, aromatic hydrocarbons, and alcohol, according to the MSDS. Facility 3 had recently tried a sample of another substitute blanket wash, but found it to be too oily; they had difficulty removing the residue from the blanket. In their typical cleaning procedure, the press operator pours the wash onto a reusable shop towel from a squirt bottle, and wipes the ink off the blanket. Both the baseline wash and the facility's standard product evaporated quickly and there was no need to remove excess wash.

For light or medium ink coverage, the press operator evaluated the performance of Wash 1 as "fair;" it removed the ink well, but left an oily residue on the blanket. To remove this residue, the press operator had remove the excess wash from the blanket with a dry shop towel. The press operator felt the extra effort of the drying step required for Wash 1 was minimal, and if that were the only disadvantage to Wash 1, he would have considered using the product regularly. However, in the case of heavy ink coverage, performance was considered "poor;" Wash 1 did not cut the ink well, even when the product was applied twice. The press operator felt the effort, time, and product needed to clean a blanket with heavy ink coverage were excessive.

Facility 6

Facility 6 prints credit cards and identification cards on plastic sheets using conventional inks. Wash 1 was used on a single-unit, 18" x 25" press. Currently, this facility cleans their blankets using a wash which, according to the MSDS, consists of aliphatic petroleum distillates, aromatic petroleum distillates, 1,2,4-trimethylbenzene, nonylphenoxypoly (ethyleneoxy) ethanol, diisononyl phthalate, 2,6,-di-tert-butyl-p-cresol. Each blanket is typically wiped down four times during cleaning: three times to remove the ink with reusable shop towels soaked with blanket wash, and once with a shop towel soaked with a more volatile cleaner to thoroughly dry the blanket. Blanket wash is applied to the shop towel using a squirt bottle and the last shop towel from the previous wash is used as the first shop towel on the next wash. The same shop towels are used until there is too much ink build-up on the shop towel to effectively remove ink. The application procedure was modified slightly for both the baseline wash and the substitute wash during the performance demonstration; a dry shop towel was used to dry the blanket rather than a drying solution.

This facility did not use Wash 1 for the full week-long demonstration period. While on-site, the observer recorded the data for four blanket washes. During this time, the performance of Wash 1 was categorized as "good" by the operator; the product cut the ink well and the blanket appeared to be clean. Compared to the baseline product, slightly more effort and time were required for Wash 1 (an average of 4 rotations or 75 seconds) than for the baseline wash (2 rotations or 38 seconds). The operator found the baseline product worked very well; it cut the ink and dried

quickly after wiping the blanket with one dry wipe, whereas the substitute wash required at least two drying rotations to fully remove excess wash from the blanket with a dry shop towel.

After the observer's visit, the press operator continued to use Wash 1. He recorded information on four more washes, rating the performance as "good." For all of these washes, ink coverage was medium. He found the product had no odor, which he preferred to the unpleasant odor of this facility's standard product. However, after four blanket cleanings, the press operator noticed problems with the subsequent print job. He found that the blanket did not take the ink well and that the image of the previous job was showing up on the next job printed. The press operator felt these problems with print quality were associated with Wash 1 and he discontinued using the product. After switching back to his standard wash, he did not experience further problems with print quality.

Upon interviewing the press operator at the end of the demonstration, he felt that the product's overall performance was "poor." This is not reflected in the data since the printer discontinued using the product before he noticed the print quality problems.

Summary of Performance Demonstrations for Blanket Wash 1

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**pH**	**Flashpoint (°F)**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 1	2.3; 30%	7.8 (fluctuated during test)	230+	0.1 @ 80°F	1.5	3	4	6
Baseline Wash	6.2; 100%	6.6	50	15 @ 100°F	1.5	3	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 1 at Facility 3	1.1 ± 0.2 (n=10)[a]	2.0 ± 0.0	2.2 ± 0.5	2.5 ± 0.7	Medium	Medium	High	*Based on a sample size of 10 blanket washes:* • Good performance for light or medium ink coverage. • Poor performance for heavy ink coverage; the extra time and effort needed were unacceptable. • Left a slight residue that was removed with a dry shop towel.
Baseline Wash at Facility 3	1.0 (n=1)	NA	1	NA	NA	Medium	NA	• Good performance. • It dried quickly and removing excess wash with a dry shop towel was not required.
WASH 1 at Facility 6	1.5 ± 0.6 (n=4)	NA	4.0 ± 0.0	NA	NA	Medium	NA	*Based on a sample size of 4 blanket washes:* • Poor performance. • Print quality problems: image of the previous job was showing.
Baseline Wash at Facility 6	1.5 (n=1)	NA	2	NA	NA	Low	NA	• Good performance • Cut the ink well without extra effort.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = number of washes on which this data is based, as recorded by the printer.

[b] Time required to clean the blanket measured by the number of blanket rotations: Avg. time per rotation = 18.8 sec. at Facility 3 and 13.8 sec. at Facility 6 (based on time recorded by the observer)

Blanket Wash 6

Composition:
Fatty acid derivatives
Hydrocarbons, petroleum distillates
Solvent naphtha (petroleum), heavy aromatic
Alkyl benzene sulfonates

VOC Content: 47%; 3.5 lbs/gal
Flashpoint: 152°F
pH: 5.5

Facility 11

Wash 6 was tested on a 5-unit, 19" x 26" press at Facility 11. During the performance demonstration, conventional and vegetable-based inks were used to produce commercial products such as brochures, publications, and mailings. Facility 11 had tried using alternative blanket washes for worker health and safety or environmental reasons on four occasions prior to the performance demonstration, but use of all four products had been discontinued due to odor problems. Currently, Facility 11 uses a blanket wash which, according to the MSDS, consists of petroleum naphtha, dipropylene glycol methyl ether, and 1,8(9)-nenthadiene. Normal blanket wash procedure consists of three wipes with a reusable shop towel saturated with blanket wash, followed by a single wipe with a clean dry shop towel to remove excess wash and dry the blanket. The blanket wash is applied to the shop towel with a squirt bottle. If possible, the shop towels were used to clean more than one blanket. This standard application method was also used for the performance demonstration.

On average, Wash 6 and the baseline wash received performance ratings of fair on the good-fair-poor scale across all ink coverages. The baseline wash was used on light and medium ink coverages, whereas Wash 6 performance was demonstrated at all levels of ink coverage. Wash 6 cut the ink as well as the baseline wash and required slightly less time (as measured by blanket rotations) to complete the blanket wash procedures. The effort required to remove ink increased for Wash 6 from a medium to high level on heavy coverage jobs, however, while the effort required to wash the blanket was a medium level for the baseline wash on light and medium ink coverages. Press operators commented that Wash 6 had an especially difficult time cutting black inks.

According to press operators, Wash 6 did not soak into the wipe as well as the baseline or standard facility washes, causing some delays in the blanket wash-up procedure, as press operators waited for the wash to slowly absorb into the shop towel material. Press operators also noticed a slight oily film remaining on the blanket from Wash 6, even after the dry wipe step. The oily residue caused problems with print quality; subsequent print jobs required a greater number of copies than usual to reach acceptable print quality. Wash 6 odor was considered slightly strong by press operators.

Facility 15

Facility 15 used Wash 6 on a brand new, 2-unit, 19" x 25" press to print commercial printing products such as brochures with conventional inks. Facility 15 had experimented with an alternative blanket wash for environmental, worker health and safety reasons prior to the performance demonstration, but had not adopted the wash due to its "ferocious" odor. Standard facility blanket wash was a petroleum naphtha-based product, according to the MSDS. Standard blanket washing procedure consisted of a two wipe process: one reusable cloth shop towel is used to apply the blanket wash to the blanket and remove the ink, and another clean and dry reusable

cloth shop towel is used to remove the excess wash and dry the blanket. The blanket wash is applied to the reusable shop towel with a squirt bottle; a small (approximately one ounce) and relatively consistent quantity of blanket wash is applied for each cleaning. This standard application process was used throughout the performance demonstration.

The press operator who conducted the week-long demonstration felt that Wash 6 performed worse than both the baseline wash and the facility standard wash. The baseline wash received a good performance rating, whereas Wash 6 received a poor rating on the good-fair-poor scale. The press operator's major complaint was that the thick consistency of Wash 6 caused delays during the wash application process; the viscous substitute wash required time to slowly soak into the shop towel material before blanket washing could begin. The press operator experimented with reducing the quantity of blanket wash in order to minimize delays, but the reduced volume was insufficient to finish a blanket in one wash application. The application shop towels were identical in material and size to other reusable laundered shop towels observed at other facilities. The viscosity problem was the only complaint about the substitute wash, however, as it performed well in all other areas. According to the press operator, Wash 6 cut the ink well, did not leave a residue on the blanket, and did not require a greater overall effort to clean the blanket than the baseline wash. The quantity of Wash 6 used to clean a blanket was also less than that of the baseline wash. In the opinion of the press operator, the effort required to apply the substitute wash to the shop towel outweighed these considerations, however. Wash 6 was categorized as requiring a high level of effort. In comparison, the baseline wash required low effort according to the press operator.

Summary of Performance Demonstrations for Blanket Wash 6

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 6	3.5; 47%	152	5.5	0.2 @ 68°F	0.7	1.5	8	6
Baseline Wash	6.2; 100%	50	6.6	15 @ 100°F	1.5	3	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 6 at Facility 11	1.0 ± 0.2 (n=11)[a]	2.5 ± 0.8	2.5 ± 0.6	3.0 ± 0.0	Medium	Medium	High	*Based on a sample size of 11 blanket washes:* • Left oily residue that interfered with print quality. • Did not readily absorb into shop towel due to thick consistency. • Fair performance overall; more effort required with heavy ink coverage.
Baseline Wash at Facility 11	0.7 ± 0.2 (n=4)	3.7 ± 0.6	3.0 ± 0.0	NA	Medium	Medium	NA	• Received good performance rating. • Did not perform as well as facility standard wash.
WASH 6 at Facility 15	0.9 ± 0.2 (n=23)	2.7 ± 0.5	3.6 ± 0.5	3.9 ± 0.4	High	High	High	*Based on a sample size of 23 blanket washes:* •Cut ink well. • Did not readily absorb into shop towel due to thick consistency; created delays and effort necessary to clean was rated "high." • Did not leave a residue on the blanket.
Baseline Wash at Facility 15	1.5 ± 0.7 (n=2)	2.0 ± 0.0	NA	NA	Low	NA	NA	• Cut ink well, with low effort. • Slight odor.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = number of washes on which this data is based, as recorded by the printer.

Blanket Wash 9

Composition:
Fatty acid derivatives
Water
Ethoxylated nonylphenol

VOC Content: 10%; 0.77 lbs/gal
Flashpoint: 230+°F
pH: 4.6

Facility 10

At Facility 10, performance demonstrations were conducted on a six-unit, 19" x 28" press using conventional inks. This facility primarily prints commercial products, such as brochures, cards, and posters. Currently, Facility 10 uses a naphtha blend as their standard wash. They have tried a few alternative washes, but found that they either did not work as well, or that they cost more than twice as much as their standard blanket wash. Typically, the facility cleans the blanket as follows: wipe the blanket with a wet sponge to remove built-up paper and particles (1-2 rotations); pour blanket wash onto a reusable shop towel from a squeeze bottle; wipe blanket with product (2 rotations); wipe off excess with a clean, dry shop towel (1-2 rotations). The baseline product and Wash 9 were applied using the same procedure.

When using Wash 9, the operator rated the performance as "poor." After the first four blanket washes, the press operator discontinued use of the product. Compared to the baseline wash, which cut the ink well, the substitute wash required excessive effort and time (up to 12 rotations or 3 minutes, compared to 5 rotations or 1.25 minutes with the baseline wash), and still did not cut the ink. Although none of the four blankets washed had heavy ink coverage, Wash 9 still was not able to remove the ink to the satisfaction of the press operator. Before continuing the print job, the operator cleaned all the blankets again with his standard wash. Additionally, the thick, creamy consistency of the wash did not allow it to soak into the shop towel; this made for a messy application as the wash dripped from the blanket onto the floor and onto other parts of the press during the blanket washing procedure. After the four blanket washes, the operator varied the application procedure somewhat in an effort to improve performance. To try to get the wash to soak into the shop towel, the operator tried using a shop towel dampened with water instead of a dry one to apply the wash. This did not improve the absorption of Wash 9 into the shop towel or the performance in cleaning the blanket. Because this facility re-washed the blankets with their standard product before starting the next print job, it is unclear as to whether this blanket wash would have an affect on future print quality or not.

Facility 15

Facility 15 prints commercial products (brochures), direct-mail products, and other publications. Performance demonstrations at this facility were conducted on a two-unit 19" x 25" press using conventional inks. The standard wash contains aromatic hydrocarbons, polyglycol ether, and aliphatic hydrocarbons, according to the MSDS. The press operator noted that while the standard wash cuts the ink well, it does have somewhat of an odor. In the past, Facility 15 tried an alternative blanket wash, but it did not work well and it had a very offensive odor. Recently, this facility installed a new press with an automatic blanket washer. In their standard blanket washing procedure, the press operator at this facility pours the blanket wash on to a reusable shop towel, wipes the ink off the blanket in one rotation, then uses a dry shop towel for one rotation to remove the excess wash. This procedure was used for both the baseline and the substitute wash.

Over the course of the week, Facility 15 washed 21 blankets with the Wash 9. While the baseline wash performance was "good" and cut the ink well with minimal effort, the overall performance of Wash 11 was consistently rated as "poor" at all levels of ink coverage. The press operator noted several reasons for the poor performance: the thickness of the wash prevented it from soaking into the shop towel thoroughly; when applied to the blanket, Wash 9 did not cut the ink well; it required excessive effort (more than twice as much as the baseline product); and, it did not dry well on the blanket. Although the wash did not seem to affect future print quality, the operator felt he had to carefully and thoroughly dry the blanket to avoid print quality problems.

Summary of Performance Demonstrations for Blanket Wash 9

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 9	0.77; 10%	230+	4.6	< 1.0 @ 77°F	1.5	1.5	19	30
Baseline Wash	6.2; 100%	50	6.6	15 @ 100°F	1.5	3	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 9 at Facility 10	3.1 ± 0.3 (n=4)[a]	11. ± 1.4	11. ± 1.4	NA	High	High	NA	*Based on a sample size of 4 blanket washes:* • Poor performance. • Did not cut ink well, required excessive effort, and did not soak into shop towel. • Discontinued use of Wash 9 after 4 washes.
Baseline Wash at Facility 10	1.5 (n=1)	NA	NA	5	NA	NA	Medium	• Good performance; cut heavy ink coverage well. • Operator noted a strong odor.
WASH 9 at Facility 15	0.7 ± 0.1 (n=21)	3.6 ± 0.5	3.9 ± 0.4	4.7 ± 0.6	High	High	High	*Based on a sample size of 21 blanket washes:* • Poor performance. • Did not soak into the shop towel. • Required much more effort than the baseline.
Baseline Wash at Facility 15	1.5 ± 0.7 (n=2)	2.0 ± 0.0	NA	NA	Low	NA	NA	• Good performance. • Cut ink well with minimal effort.

NA = Not Applicable; product was not demonstrated under these conditions.
NC = Not calculated; VOC content as a % by weight could not be calculated because a specific gravity was not available.
[a] n = number of washes on which this data is based, as recorded by the observer (Facility 10) and by the printer (Facility 15).
[b] Time required to clean the blanket measured by the number of blanket rotations. Avg. time per rotation = 15.0 sec. at Facility 10 and 35.0 sec. at Facility 15 (based on time recorded by the project observer)

Blanket Wash 10

Composition:
Fatty acid derivatives
Water

VOC Content: 2%; 0.16 lbs/gal
Flashpoint: 230+°F
pH: 5.7

Facility 3

Facility 3 used Wash 10 on a 2-unit, 18" x 25" press, using conventional inks to print a variety of commercial products. Facility 3 had used a new blanket wash for health, safety, or environmental reasons on one occasion prior to the performance demonstration, but the wash had not been adopted because it left an oily residue on the blanket and took too long to dry. Normal blanket washing procedure is the following: a squirt bottle is used to apply blanket wash to a reusable shop towel, the shop towel is then used to wipe the blanket as it is manually rotated, and the blanket is allowed to air dry. Standard facility blanket wash was a mixture of aliphatic and aromatic hydrocarbons, according to the MSDS. The application procedure was not changed for the performance demonstration.

The press operator cleaned four blankets with Wash 10 before declining to conduct a performance demonstration of the product due to its poor performance. Wash 10 did not absorb into the application shop towel, creating safety and cleanliness problems in the pressroom as excess wash dripped on the floor and press. A variety of methods were tried to get the wash to absorb into the standard reusable application shop towel, but none were successful. These methods included cupping the shop towel to keep the blanket wash from running off of the surface immediately, applying the blanket wash to the shop towel on a flat surface and then folding the shop towel over the applied wash, and placing the mouth of the applicator bottle directly onto the surface of shop towel to contain the wash until it had fully absorbed. In addition, Wash 10 did not cut the ink well. According to the press operator, 3-4 times the effort required to use the baseline wash was necessary to remove ink from the blanket with Wash 10 under light ink coverage conditions.

Facility 4

Wash 10 was used on a 4-unit, 34" x 40" press at Facility 4 which does most of its business in commercial printing products such as software manuals and calendars. Facility 4 uses a solution of aliphatic hydrocarbons, aromatic hydrocarbons, and surfactants, according to the MSDS, as the standard blanket wash. Blanket wash procedure at Facility 4 consists of a two wipe process. Blanket wash is applied to a clean, dry, and reusable shop towel which is used to wash the blanket. Another clean dry shop towel is then used to remove excess wash and dry the blanket. If ink buildup on the shop towels is not significant, the shop towels are used to wash more than one blanket. If paper coating is deposited on the blanket from the job, the blanket wash shop towel is dipped into a bucket of water before wiping down the blanket. This standard blanket washing procedure was not modified for the performance demonstration.

The press operator at Facility 4 used Wash 10 to clean four blankets before declining to conduct a performance demonstration of the product due to its poor performance. Under medium ink coverage conditions, Wash 10 did not cut the ink well and required considerably more effort then the standard facility wash or baseline wash of the performance demonstration. An average

of six blanket rotations were necessary to clean the blanket, two times more than were necessary with the baseline and standard washes. In addition, Wash 10 did not soak well into the standard reusable shop towels at Facility 4, creating further delays. A variety of methods were tried to get the wash to absorb into the application shop towel, but none were successful. These methods included cupping the shop towel to keep the blanket wash from immediately running off of the shop towel surface, applying the blanket wash to the shop towel and then folding the shop towel over the applied wash, and placing the mouth of the applicator bottle directly onto the surface of shop towel to contain the wash until it had fully absorbed. The press operator, who had broken into a sweat from the effort required to use Wash 10, declined to use the product for the week-long performance demonstration.

Summary of Performance Demonstrations for Blanket Wash 10

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 10	0.16; 2%	230+	5.7	17.5 @ 68°F	0.7	0.7	12	13
Baseline Wash	6.2; 100%	50	6.6	15 @ 100°F	1.5	3	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 10 at Facility 3	1.0 ± 0.0 (n=4)[a]	2.0 ± 0.0	2.0 ± 0.0	NA	High	High	NA	*Based on a sample size of 4 blanket washes:* • Printer declined to test product due to level of effort required to clean blanket. • Did not absorb well into shop towel. • Did not cut ink well.
Baseline Wash at Facility 3	1.0 (n=1)	NA	1.0 ± 0.0	NA	NA	Medium	NA	• Good performance: cut the ink well. • Slight, unpleasant odor.
WASH 10 at Facility 4	3.0 ± 0.0 (n=4)	NA	6.2 ± 0.5	NA	NA	High	NA	*Based on a sample size of 4 blanket washes:* • Printer declined to test product due to level of effort required to clean blanket. • Did not absorb well into shop towel. • Did not cut ink well.
Baseline Wash at Facility 4	3.0 ± 0.0 (n=2)	NA	3.0 ± 0.0	NA	NA	Low	NA	• Good performance: cut the ink well. • Slight, unpleasant odor.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = number of washes on which this data is based, as recorded by the observer.

[b] Time required to clean the blanket measured by the number of blanket rotations. Avg. time per rotation = 30.0 sec. at Facility 3 and 202.5 sec. at Facility 4 (based on time recorded by the project observer)

Blanket Wash 11

Composition:
Fatty acid derivatives
Hydrocarbons, petroleum distillates
Hydrocarbons, aromatic
Alkyl benzene sulfonates

VOC Content: 61%; 4.3 lbs/gal
Flashpoint: 150°F
pH: 5.0 (fluctuates wildly)

Facility 1

At Facility 1, performance demonstrations were conducted on an eight-unit, 28" x 40" press using vegetable-based inks to print high quality, multi-color, commercial products. Currently, Facility 1 uses a blanket wash which, according to the MSDS, consists of aromatic hydrocarbons, 1,2,4-trimethylbenzene, and aliphatic hydrocarbons. In the months preceding the demonstrations, the facility had tried two different low-VOC blanket washes; neither worked as well as their standard wash. At this facility, each blanket is typically wiped down twice during cleaning: once with a reusable shop towel saturated in blanket wash to remove the ink, and once with a dry shop towel to remove excess blanket wash. Each saturated shop towel is used to clean two blankets. The same application procedure was used for the baseline and substitute products. The quantity of wash needed to saturate the shop towel and clean the blanket remained constant throughout the demonstration, regardless of the ink coverage or ink build-up on the blanket. There were both positive and negative aspects to this application method. While more wash than was needed may have been used in some cases, the consistency of the application volume made it possible to compare the performance of the standard, baseline, and substitute products under the same conditions.

In the case of light or medium ink coverage, Wash 11 cut the ink well and the press operator generally considered the performance "good" or "fair." For heavy ink coverage, performance of the product was usually evaluated as "poor." The press operator cleaned all blankets using Wash 11 for three days (26 blankets) until he ran out of the substitute wash. Extra time and effort were needed, however, to remove the oily residue from the blanket when compared to the baseline product. Wiping the blanket with one clean, dry shop towel (as was used with their standard blanket wash and with the baseline wash) did not completely remove the residue; oily streaks of wash remained on the blanket. The press operator was able to remove the residue by wiping the blanket with a clean shop towel that was dampened with water, followed by a clean, dry wipe. This extra step reduced the oily residue, but increased the time and effort required to wash the blanket (from 2 rotations or 40 seconds with the baseline wash to 3 - 4 rotations or 60 - 80 seconds with Wash 11).

In the case of heavy ink coverage, the performance of Wash 11 was considered "poor." The substitute wash, did not cut the ink well in cases of heavy coverage or excessive ink build-up. Since this printer has eight unit press, the ink build-up on the last print unit can be especially heavy. Because of this problem with heavy ink coverage, the printer felt this product was not a suitable substitute for his facility.

The printer found the oily residue had no overall affect on the print quality: while it made the blanket less tacky which *reduced* the time to get back up to acceptable quality, the same residue washed out the color somewhat, which *increased* the sheets required to achieve acceptable print quality.

Facility 2

Facility 2 used a three-unit, 13" x 18" press for the performance demonstrations. This facility prints commercial products (brochures, flyers, cards) using both conventional and vegetable oil-based inks. Their standard wash consists of aromatic hydrocarbons, 1,2,4-trimethylbenzene, and aliphatic hydrocarbons, according to the MSDS. The press operator noted that the standard wash cuts the ink well, but does have somewhat of an odor. In the past, Facility 2 has tried two substitute blanket washes: performance was rated as poor ("it did not work at all") for one product, and the other product they tried was too expensive. In their standard blanket washing procedure, the press operator at this facility pours the blanket wash onto a reusable shop towel from a squirt bottle, wipes the ink off the blanket in one rotation, then uses a dry shop towel for one rotation to remove the excess wash. This application procedure was also used for both the baseline and the substitute washes.

The performance of Wash 11 was considered "good" or "fair" when ink coverage was light or medium. For heavy ink coverage, the wash performance was evaluated as "poor." Facility 2 used Wash 11 for one week , recording information on 31 blanket cleanings. When ink coverage was light or medium, the Wash 11 usually matched the baseline level of performance, which was rated as "good." The baseline wash cut the ink very well; the quantity, effort, and time required were the same as with this facility's standard product. The performance of Wash 11 was comparable to the baseline for light/medium ink coverage requiring an average of two cleaning rotations, two wipes, and approximately one ounce of product to clean the blanket. For heavy ink coverage, however, an average of 8 rotations (ranging from 4 up to 12), 5 wipes, and 4 ounces of Wash 11 were needed to clean the blanket. In addition to the extra time and quantity of product needed, removing the heavy coverage ink required additional physical effort. The overall product performance for removing heavy ink coverage was considered "poor," although Wash 11 ultimately did remove the ink and did not affect print quality.

In all cases, Wash 11 left an oily residue on the blanket which was removed with a dry shop towel. Removing this oily residue did not require any time or effort beyond their standard method where the blanket is wiped with a dry shop towel for one rotation.

Summary of Performance Demonstrations for Blanket Wash 11

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**pH**	**Flashpoint (°F)**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 11	4.3; 61%	5.0 (fluctuated during test)	150	0.2 @ 68°F	0	1.5	4	5
Baseline Wash	6.2; 100%	6.6	50	15 @ 100°F	1.5	3	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 11 at Facility 1	2.5 ± 0.6 (n=26)[a]	3.0 ± 0.0	3.5 ± 0.7	4.0 ± 0.8	Medium	Medium	High	*Based on a sample size of 26 blanket washes:* • Good performance for light/medium ink coverage. • Extra time and effort needed for heavy ink coverage. • Left slight, oily residue on blanket, but it did not affect the print quality.
Baseline Wash at Facility 1	2.5 ± 0.0 (n=2)	2.0 ± 0.0	2.0 ± 0.0	NA	Medium	Medium	NA	• Good performance. • Required slightly more effort than their standard product to remove excess wash.
WASH 11 at Facility 2	1.5 ± 1.5 (n=31)	2.1 ± 0.6	2.0 ± 1.2	8.2 ± 3.5	Medium	Medium	High	*Based on a sample size of 31 blanket washes:* • Good/fair performance for light/medium ink coverage. • Extra time and effort were required for heavy ink coverage. • Left slight, oily residue on blanket, but it did not affect the print quality.
Baseline Wash at Facility 2	1.2 ± 0.8 (n=3)	2.7 ± 1.1	NA	NA	Medium	NA	NA	• Good performance • Cut ink as well as their standard wash.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = number of washes on which this data is based, as recorded by the printer.

[b] Time required to clean the blanket measured by the number of blanket rotations: Avg. time per rotation = 23.2 sec. at Facility 1 and 10.0 sec. at Facility 2 (based on time recorded by the observer)

Blanket Wash 12

Composition:
Hydrocarbons, petroleum distillates
Water

VOC Content: 20%; 1.3 lbs/gal
Flashpoint: 125°F
pH: 8.2

Facility 12

At Facility 12, Wash 12 was used on a 6-unit, 28" x 40" press with conventional inks. A variety of commercial products on a variety of paper types were printed during the performance demonstration: from posters on glossy stock to information cards on cardboard stock. Wash 12 was used approximately thirty times during the week-long performance demonstration. In the typical blanket washing procedure at Facility 12, each blanket is wiped twice: once with a reusable shop towel saturated with blanket wash from a plunger can, and once with a dry reusable shop towel to remove the excess blanket wash. The blanket wash shop towel is often used on more than one blanket, depending on the cleanliness of the shop towel as well as the ink coverage. The standard facility wash is a petroleum naphtha-based product, according to the MSDS. In the performance demonstration, the only change in application procedure was that Wash 12 was directly applied to each shop towel for the application process and the plunger can was not used. Wash 12 was diluted 50% with water at Facility 12.

Wash 12 was considered approximately equal to the baseline wash in overall performance; both received fair ratings on the good-fair-poor scale. According to press operators, Wash 12 required less effort than the baseline wash, but more time to complete the wash procedure. The number of rotations increased from an average of 3.0 for the baseline wash to 4.6 for Wash 12, approximately equal to a time increase of one and a half minutes per blanket at this facility. Wash 12 cut the ink satisfactorily, but not well, at all ink coverages, and did a poor job of cutting through paper residue on the blankets. On print runs that coated the blanket with paper residue, 12 rotations were necessary to clean the blanket, while only 4 rotations were needed for print runs without paper residue. Use of Wash 12 was discontinued on paper residue coated blankets due to this increased time requirement. The problem with paper residue was not related to ink coverage; the major increase in number of rotations occurred on a light coverage job. Some inconsistencies also arose with print quality. In some cases, after the blanket was cleaned, the color came back faster than with the baseline and regular washes (10 impressions instead of 20). At other times, however, Wash 12 may have caused dull spots to appear on the printed image.

Facility 13

Facility 13 used Wash 12 on a 2-unit, 20" x 26" press during the performance demonstration. Performance demonstration print jobs were primarily folders and brochures printed with light conventional ink coverage on glossy enamel paper. The blanket washing procedure at this facility involves two disposable paper shop towels: one is saturated with blanket wash from a squirt bottle and used to clean the blanket; the other is used dry to remove excess wash and dry the blanket. During this process, the blanket is rotated incrementally under manual control. The standard application method was not changed for the performance demonstrations.

Wash 12 was used for two one week trial periods in order to experiment with a variety of dilution ratios, ranging from 50% to 0% water. Averaged over all dilution ratios, Wash 12 required

slightly less effort than the baseline wash, but was only considered a fair performer overall by the press operator. The time required to wash the blanket (as measured by number of rotations) was equal for the baseline wash and Wash 12 when averaged across dilution levels. However, as the ratio of blanket wash to water increased, the performance of Wash 12 improved. A 50% mixture of blanket wash and water left the blanket "wet" and solicited a poor performance rating from the press operator under all ink coverages. When the percentage of water was decreased to 25% of the overall mixture, the wash performance was generally rated as fair to good across all print ink coverages. The undiluted blanket wash performed the best. The press operator conducting the trials commented that the undiluted blanket wash performed better than the baseline wash and even surpassed the performance of the standard facility blanket wash in all categories. The undiluted wash received good performance and low effort ratings every time it was used. Product instructions, however, indicate that the blanket wash should be mixed from 1:1 to 1:8 with water. The press operator commented that the blanket wash odor was faint at all dilution levels, but was not disagreeable.

Summary of Performance Demonstrations for Blanket Wash 12

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 12	1.3; 20%	125	8.2	0.7 @ 68°F	0	1.5	7	11
Baseline Wash	6.2; 100%	50	6.6	15 @ 100°F	1.5	3	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 12 at Facility 12	5.4 ± 0.8 (n=16)[a]	12.0 ± 0.0	4.0 ± 0.6	4.5 ± 0.6	High	Medium	Medium	*Based on a sample size of 16 blanket washes:* • Caused potential print quality problems. • Was considered equal to baseline wash in overall performance. • Had difficulty cutting paper residue. • Wash was diluted 50% with water.
Baseline Wash at Facility 12	4.4 ± 1.6 (n=6)	4.0 ± 0.0	2.5 ± 1.0	NA	High	High	NA	• Required greater effort than standard wash. • Did not cut ink as well as standard wash.
WASH 12 at Facility 13	1.8 ± 0.4 (n=19)	1.0 ± 0.0	1.0 ± 0.0	1.0 ± 0.0	Medium	Medium	Medium	*Based on a sample size of 19 blanket washes:* • When not diluted with water, performance surpassed baseline and standard washes. • At most dilution levels, required slightly less effort than baseline wash. • Overall fair performance rating across ink coverages and dilutions.
Baseline Wash at Facility 13	2.1 ± 0.5 (n=4)	1.0 ± 0.0	1.0 ± 0.0	NA	Medium	High	NA	• Good performance, cut the ink well. • Removed ink in one rotation.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = number of washes on which this data is based, as recorded by the printer.

[b] Time required to clean the blanket measured by the number of blanket rotations: Avg. time per rotation = 48.0 sec. at Facility 12 and 62.5 sec. at Facility 13

Blanket Wash 14

Composition:
Fatty acid derivatives
Propylene glycol ethers
Water

VOC Content: 12%; 0.97 lbs/gal
Flashpoint: 230+°F
pH: 5.0

Facility 6

At Facility 6, Wash 14 was used on a single-unit, 18" x 24" press and a single-unit 18" x 25" press with conventional inks to print credit cards, identification cards and other products on plastic substrates. The press operator cleaned all blankets using Wash 14 for the week-long demonstration. At this facility, each blanket is typically wiped down four times during cleaning: three times to remove the ink with reusable shop towels soaked with blanket wash; and once with a shop towel soaked with a more volatile wash to dry the blanket. Currently, this facility cleans their blankets using a wash which contains aliphatic petroleum distillates, aromatic petroleum distillates, 1,2,4-trimethylbenzene, nonylphenoxypoly (ethyleneoxy) ethanol, diisononyl phthalate, and 2,6,-di-tert-butyl-p-cresol, according to the MSDS. The blanket wash is applied to the shop towel using a squirt bottle and the shop towel is resoaked with wash prior to reuse on other blankets. The same shop towels are used until there is too much ink buildup on the shop towel to effectively clean the blanket. During this procedure, the blanket turns automatically at a constant rate. This application procedure was modified for the substitute product demonstration by replacing the Tru-dot cleaner used in the last step with a dry shop towel to dry the blanket.

Overall, the performance of Wash 40 was considered "good" on all ink coverages, although it required almost twice as many rotations (eight rotations) to clean a blanket with heavy ink coverage than to clean a blanket with medium ink coverage. The press operator found that Wash 14 cut the ink well; with about the same effectiveness as the baseline wash which the operator also found to cut the ink well. Some additional time and effort were needed to remove a slight oily residue left by the substitute wash using a clean dry shop towel. The average time required to rotate a blanket was measured to be 22.5 seconds, therefore it required an extra 1.5 minutes to clean the blanket with heavy ink coverage. The amount of extra effort required, however, was considered to be a "medium" amount for light and medium ink coverages and "high" when cleaning a blanket with a heavy ink coverage. The quantity of substitute wash used was slightly lower than the quantity of baseline wash used. At all levels of ink coverage, no print quality problems attributable to Wash 14 were experienced. The press operator also noticed that Wash 14 did not have a strong solvent smell as opposed to the facility's standard wash or the baseline wash.

Facility 16

Facility 16 used a 2-unit 20" x 26" press with conventional inks to print advertisements, cards, and other commercial products. The press operator at Facility 16 used Wash 14 for all jobs during the one-week demonstration. At this facility, each blanket is typically wiped down three times during cleaning: once with a wet sponge to remove paper dust (when needed); once with a reusable shop towel soaked with naphtha (which is also the baseline wash used throughout the demonstrations); and finally with a clean dry shop towel to remove excess wash. This application procedure was also used for the application of the substitute wash. Facility 16 has tried substitute, low-VOC blanket washes in the past, but found that the products were not acceptable because they did not dry on the blanket as fast as their standard wash.

Overall, at Facility 16 the performance of Wash 14 was considered "fair". The press operator found that Wash 14 did not cut ink as well as the baseline wash, especially on black inks and in cases of heavy ink build up. Wash 14 was tested under light and medium ink coverage conditions while the baseline wash was observed only under heavy ink coverage conditions. Because the baseline wash is normally used at the facility, the operator's familiarity with the baseline wash allowed him to make accurate comparisons between the substitute wash and the baseline wash under all ink coverage conditions. The substitute wash required more time and effort to clean the blanket than the baseline wash because additional rotations were required to remove the ink. The substitute wash typically required one extra blanket rotation with a blanket wash soaked shop towel. On average, this press operator required 20.8 seconds per blanket rotation, so the actual time to clean a blanket using Wash 14 was not increased significantly. The press operator found that a larger volume of Wash 14 was also needed to remove the ink in comparison to the baseline wash (2.0 ounces for the baseline wash compared to 2.8 ounces for the substitute wash). The overall time and effort to clean the blankets was also a factor of the thick consistency of the substitute wash which made it difficult for the operator to get the product to soak into the shop towel.

Summary of Performance Demonstrations for Blanket Wash 14

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 14	0.97; 12%	230+	5	17.5 @ 68°F	1.5	3	8	10
Baseline Wash	6.2; 100%	50	6.6	15 @ 100°F	1.5	3	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 14 at Facility 6	1.3 ± 0.6 (n=15)[a]	4.3 ± 0.6	4.4 ± 0.5	8.0 ± 0.0	Medium	Medium	High	*Based on a sample size of 15 blanket washes:* • Good performance; cut ink well. • Extra effort was required to remove the oily residue that the wash left on the blanket.
Baseline Wash at Facility 6	1.5 (n=1)	NA	2.0 ± 0.0	NA	NA	Low	NA	• Good performance; cut ink well.
WASH 14 at Facility 16	2.8 ± 0.5 (n=34)	3.2 ± 0.6	4.0 ± 0.5	NA	High	High	NA	*Based on a sample size of 34 blanket washes:* • Did not cut ink as well as the baseline wash. • Black inks and heavy ink build up are especially difficult to clean. • Thick consistency of the wash made it difficult to soak into shop towel.
Baseline Wash at Facility 16	2.0 ± 0.0 (n=3)	NA	NA	3.0 ± 0.0	NA	NA	Low	• Baseline wash is facility's standard wash.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = number of washes on which this data is based, as recorded by the printer.

[b] Time required to clean the blanket measured by the number of blanket rotations: Avg. time per rotation = 22.5 sec. at Facility 6 and 20.8 sec. at Facility 16 (based on time recorded by the project observer)

Blanket Wash 19

Composition:
Fatty acid derivatives
Propylene glycol ethers
Water

VOC Content: 22%; 1.8 lbs/gal
Flashpoint: 230+°F
pH: 4.6

Facility 18

At Facility 18, Wash 19 was used on a single-unit 20" x 30" press and a 2-unit, 19" x 26" press with soy oil-based inks. Commercial products such as business forms and brochures were printed. The press operator used Wash 19 for the four days that the presses were operating during the one-week demonstration period which resulted in only five blanket cleanings. At this facility, each blanket is typically wiped down three times during cleaning: twice with a reusable rag soaked with blanket wash, and once with a dry rag to remove excess blanket wash. Blanket wash is applied to the rag using a squirt bottle and the rag is resoaked with wash prior to reuse on other blankets. The same rag is used until it has too much ink build-up to effectively clean the blanket. Currently, this facility cleans their blankets using a wash which contains aliphatic hydrocarbons, according to the MSDS. Other than changing the number of rotations to clean a blanket, this application procedure was not modified during the demonstration of the substitute product. Facility 18 had tried an alternative low-VOC blanket wash, but found that it did not dry as fast as their standard product and was more expensive.

Based on the five blanket cleanings with Wash 19, the press operator at Facility 18 evaluated its performance as "poor". The press operator found that Wash 19 cut ink sufficiently only when applied to the blanket generously. The baseline wash was found to cut the ink well, but required additional effort due to the wash's high resistance to the blanket surface. On average, more than three times as much of Wash 19 was used compared to the baseline wash. The thick consistency of the substitute wash also contributed to the larger quantity of wash needed, as well as increased time and effort to clean a blanket in comparison to the baseline wash. The press operator had difficulty getting the product to soak into the rag, which resulted in a large amount of wash being applied to the blanket on the first few swipes of the rag and a comparatively small amount near the end of the blanket rotation. The press operator would then need to rotate the blanket additional times, applying more substitute wash to ensure that the necessary amount of blanket wash reached all areas of the blanket. This significantly increased the average number of rotations required to clean a blanket, especially in the case of light ink coverage where rotations increased from 2.7 rotations for the baseline wash to 8.0 rotations for the substitute. Because the average time to rotate a blanket was 16.2 seconds at Facility 18, the average blanket cleaning time increased by 1.4 minutes over the baseline wash for light ink coverage. The effort needed to use Wash 19 was evaluated as "high" due to its thick consistency and the extra rotations it required. The press operator observed that the wash cut the ink better on the first few swipes where the wash on the blanket was relatively thick in comparison to other areas with a thinner layer of wash. The press operator also noticed that the ability of the substitute wash to remove ink was better when it was allowed to sit on the blanket for a few minutes before being removed.

Facility 19

Facility 19 used a 2-unit 19" x 26" press also with soy oil-based inks to print brochures, cards, and other commercial products. The press operator at Facility 19 used Wash 19 for three days and then stopped because he found that the product required a significant amount of extra effort, time and quantity of wash to clean the blankets. The operator typically cleans the blanket by pouring the blanket wash onto a clean, reusable rag and wiping the blanket while rotating it manually twice. The blanket is then allowed to dry by evaporation before restarting the press. This application procedure was also used for the application of the baseline wash. When using Wash 19, the press operator modified the application procedure slightly and wiped the blanket with a dry rag before resuming the print job. The standard wash used at this facility contains aromatic hydrocarbons, polyglycol ethers, aliphatic hydrocarbons, and a proprietary combustible chemical, according to the MSDS. Prior to this project, they did some experimenting with another substitute wash, but it did not work as well as their standard product and it was irritating to the skin as well. In the past, they used an automatic blanket washer, hoping to reduce their blanket wash chemical use and labor, but they discontinued using it after they found it required more effort and wasted solvent.

The press operator at Facility 19 evaluated the performance of Wash 19 as "poor". The operator felt that the substitute product did not cut ink as well as the baseline wash. The baseline wash was found to cut the ink well, but required additional effort due to its high resistance to the blanket surface. Some additional time was required to remove the ink using Wash 19 than was required with the baseline wash. In addition, the thick consistency of Wash 19 was found to require extra time, effort and quantity to clean the blankets. The press operator had difficulty getting the product to soak into the rag which resulted in spillage and a "messy" application. When the usual application procedure was used with the Wash 19, an oily residue remained on the blanket which increased the number of copies required to get up to print quality after restarting the press. One or two rotations with a dry rag were needed to remove the residue from the blanket before printing. The quantity of Wash 19 needed to remove the ink more than doubled in comparison to the baseline wash. The press operator rated the effort needed as "high" for both the baseline and the substitute washes. Although the performance of the baseline wash was considered to be good, the effort needed to use the baseline wash was rated as "high" because the operator found it to have high resistance to being dragged across the blanket. The effort to use the substitute wash was rated as "high" due to the extra rotations and the messy application.

Summary of Performance Demonstrations for Blanket Wash 19

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 19	1.8; 22%	230+	4.6	17.5 @ 68°F	1.5	1.5	11	9
Baseline Wash	6.2; 100%	50	6.6	15 @ 100°F	1.5	3.0	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 19 at Facility 18	4.8 ± 3.0 (n=5)[a]	8.0 ± 0.0	7.7 ± 2.1	NA	High	High	NA	*Based on a sample size of 5 blanket washes:* • Thick consistency of wash made it difficult to soak into rag and resulted in uneven application. • Large quantities were required to cut ink.
Baseline Wash at Facility 18	1.5 ± 0.8 (n=6)	2.7 ± 0.5	3.5 ± 0.7	NA	Low	Low	NA	• Good performance; cut the ink well.
WASH 19 at Facility 19	2.2 ± 0.5 (n=8)	4.0 ± 0.0	4.0 ± 0.0	4.0 ± 0.0	High	High	High	*Based on a sample size of 8 blanket washes:* • Thick consistency of wash was messy and difficult to use. • Cut demonstration short due to extra effort and time required to clean blanket.
Baseline Wash at Facility 19	0.9 ± 0.2 (n=5)	2.2 ± 0.4	NA	NA	High	NA	NA	• Good performance; cut the ink well. • Required additional effort to drag across the blanket.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = number of washes on which this data is based, as recorded by the printer.

[b] Time required to clean the blanket measured by the number of blanket rotations: Avg. time per rotation = 16.2 sec. at Facility 18 and 18.5 sec. at Facility 19 (based on time recorded by the project observer)

Blanket Wash 20

Composition:
Water
Hydrocarbons, petroleum distillates
Hydrocarbons, aromatic
Alkyl benzene sulfonates

VOC Content: 35%; 2.7 lbs/gal
Flashpoint: 170°F
pH: 7.1

Facility 11

Wash 20 was tested on a 5-unit, 19" x 26" press at Facility 11. During the performance demonstration, conventional and vegetable-based inks were used to produce commercial products such as brochures, publications, and mailings. Facility 11 had tried using alternative blanket washes for worker health and safety or environmental reasons on four occasions prior to the performance demonstration, but use of all four products had been discontinued due to odor problems. Currently, this facility's standard wash consists of petroleum naphtha, dipropylene glycol methyl ether, and 1,8(9)-nenthadiene, according to the MSDS. Normal blanket wash procedure consists of three wipes with a reusable shop towel saturated with blanket wash, followed by a single wipe with a clean dry shop towel to remove excess wash and dry the blanket. The blanket wash is applied to the shop towel with a squirt bottle. If possible, the shop towels were used to clean more than one blanket. This standard application method was also used for the performance demonstration.

Overall, Wash 20 was given a fair performance rating and a medium effort rating. On average, the baseline wash performed better overall, but also required a medium amount of effort. The time required to wash the blanket was slightly less for Wash 20 than for the baseline wash; Wash 20 required 2.8 rotations whereas the baseline wash required 3.5 rotations. However, delays resulted from an oily film sometimes left on the blanket after use of Wash 20. This film had to be removed with a third rotation, thus bringing the average number of rotations close to 3.0 for the performance demonstration. Additional delays resulted from the thick consistency of Wash 20. The press operator often had to wait for the wash to soak into the application shop towel. Greater effort was required to cut ink under heavy ink coverage situations; the press operator gave a greater proportion of high effort ratings to the wash under these conditions. Wash 20 also had difficulty cutting through light inks such as reds and yellows. Press operators did not consider the odor of Wash 20 to be significant.

Facility 12

At Facility 12, Wash 20 was used on a 6-unit, 28" x 40" press with conventional inks. A variety of commercial products on a variety of paper types were printed during the performance demonstration: from posters on glossy stock to information cards on cardboard stock. Wash 20 was used approximately thirty times during the week-long performance demonstration. In the typical blanket washing procedure at Facility 12, each blanket is wiped twice: once with a reusable shop towel saturated with blanket wash from a plunger can, and once with a dry reusable shop towel to remove the excess blanket wash. The blanket wash shop towel is often used on more than one blanket, depending on the cleanliness of the shop towel as well as the ink coverage. According to the MSDS, the standard facility wash is a petroleum naphtha-based product. In the performance demonstration, the only change in application procedure was that Wash 20 was

directly applied to each shop towel for the application process and the plunger can was not used.

Press operators at Facility 12 declined to use Wash 20 after experiencing nausea and dizziness after three trials. Wash 20 aggravated a previously existing respiratory condition in one press operator, and caused dizziness in another. These health problems coincided with a strong odor as blanket wash evaporated from the wash shop towel during the wipe process.

Summary of Performance Demonstrations for Blanket Wash 20

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 20	2.7; 35%	170	7.1	1.5 @ 77°F	0	1.5	5	7
Baseline Wash	6.2; 100%	50	6.6	15 @ 100°F	1.5	3	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[c] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 20 at Facility 11	1.4 ± 0.6 (n=17)[a]	2.0 ± 0.0	2.7 ± 0.8	4.0 ± 0.8	Medium	Medium	High	*Based on a sample size of 17 blanket washes:* • Performance considered fair, but worse than facility and baseline washes. • Left oily residue on blanket that required additional rotations to remove. • Hard to apply to shop towels due to thick consistency.
Baseline Wash at Facility 11	0.7 ± 0.2 (n=4)	3.7 ± 0.6	3.0 ± 0.0	NA	Medium	Medium	NA	• Good performance. • Slight odor.
WASH 20 at Facility 12	3.0 (n=1)[b]	NA	5.0 ± 0.0	NA	NA	High	NA	*Based on a sample size of 1 blanket wash:* • Product induced nausea in press operators; Facility declined opportunity to test product.
Baseline Wash at Facility 12	4.4 ± 1.6 (n=6)	4.0 ± 0.0	2.5 ± 1.0	NA	High	High	NA	• Required higher effort than standard wash. • Did not cut ink as well as standard wash. • Slight odor.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = number of washes on which this data is based, as recorded by the printer.

[b] n = number of washes this data is based on, as recorded by the observer.

[c c] Time required to clean the blanket measured by the number of blanket rotations. Avg. time per rotation = 95.7 sec. at Facility 11 and 120.0 sec. at Facility 12 (based on time recorded by the project observer)

Blanket Wash 21

Composition:
Hydrocarbons, aromatic
Hydrocarbons, petroleum distillates
Fatty acid derivatives

VOC Content: 47%; 3.5 lbs/gal
Flashpoint: 115°F
pH: 6.2

Facility 6

Facility 6 prints credit cards and identification cards on plastic sheets using conventional inks. Wash 1 was used on a single-unit, 18" x 25" press. Currently, this facility cleans their blankets using a wash which consists of aliphatic petroleum distillates, aromatic petroleum distillates, 1,2,4-trimethylbenzene, nonylphenoxypoly (ethyleneoxy) ethanol, diisononyl phthalate, 2,6,-di-tert-butyl-p-cresol, according to the MSDS. Each blanket is typically wiped down four times during cleaning: three times to remove the ink with reusable shop towels soaked with blanket wash, and once with a shop towel soaked with Tru-dot cleaner (a more volatile wash) to thoroughly dry the blanket. Blanket wash is applied to the shop towel using a squirt bottle and the last shop towel from the previous wash is used as the first shop towel on the next wash. The same shop towels are used until there is too much ink build-up on the shop towel to effectively remove ink. The application procedure was modified slightly for both the baseline wash and the substitute wash during the performance demonstration; a dry shop towel was used to dry the blanket rather than a drying solution.

The operator rated the performance of Wash 21 as "fair" for all levels of ink coverage. It cut the ink well, but it left an oily residue even after wiping the blanket with a dry shop towel. To remove the residue, the press operator wiped the blanket a second time with another dry shop towel. Even with the extra wiping, the operator felt the residue caused color wash-out on the next job, so that additional waste sheets (approximately 50 percent more) were needed to get back to color. After cleaning six blankets with Wash 21, the press operator switched back to using the standard wash. The operator summarized the product performance as fair: it cut the ink well, but the oily residue resulted in extra effort (to dry the blanket) and extra waste sheets (needed to get the press to color). The operator noticed Wash 21 had an odor, but he felt it was much better than the unpleasant odor of his standard wash.

Performance of the baseline product was considered good; it cut the ink well with minimal effort. Compared to Wash 21, the baseline required less effort and time to clean a blanket with medium ink coverage (2 rotations or approximately 41 seconds for the baseline compared to an average of 3.3 rotations or 61 seconds for Wash 21).

Facility 17

At Facility 17, performance demonstrations were conducted on a two-unit, 19" x 26" press with conventional inks where commercial products such as advertisements and brochures were printed. Currently, this facility uses which contains petroleum naphtha, dichloromethane, and 1,1,1-trichloroethane, according to the product's MSDS. This performance demonstration was their first experience in experimenting with substitute blanket washes. Typically the press operator cleans the blanket by pouring the wash from a squirt bottle onto a reusable shop towel

and wiping down the blanket. The wash is allowed to dry by evaporation. Occasionally the operator will mix the wash with water to remove paper dust and paper lines from the blanket.

The overall performance of Wash 21 was rated as "fair;" it cut the ink well, but it left an oily residue on the blanket. Facility 17 used the substitute wash for one week during which 25 washes were recorded by the press operator. Wash 21 cut the ink well, but it was necessary to modify the application procedure slightly and add a drying step to remove the oily residue left on the blanket after applying the wash. Although this step was not required with the facility's standard wash, the operator did not view it as particularly burdensome; level of effort was rated as "low" or "medium." Both Wash 21 and the baseline wash were only used on blankets with light or medium ink coverage; no heavy coverage jobs were run during the demonstration period. The baseline wash cut the ink well with the same level of effort as is required for the facility's standard blanket wash. Compared to the baseline wash, Wash 21 took slightly more time because of the extra drying step.

In addition to the extra effort, the printer noted that the oily residue occasionally caused problems with subsequent print jobs. In two cases, the printer noticed the prints were mottled (fuzzy edges). The printer had to run additional waste sheets to get acceptable, clear print quality. The press operator also commented that the wash did not absorb into the shop towel easily, making it messy to apply. Absorbency was improved somewhat when the wash was applied to a shop towel wet with water.

Summary of Performance Demonstrations for Blanket Wash 21

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**pH**	**Flashpoint (°F)**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 21	3.5; 47%	6.2	115	< 0.1 @ 68°F	0	1.5	7	6
Baseline Wash	6.2; 100%	6.6	50	15 @ 100°F	1.5	3	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 21 at Facility 6	2.0 ± 0.6 (n=6)[a]	2.0 ± 0.0	3.3 ± 0.6	4.0 ± 0.0	Low	Medium	High	*Based on a sample size of 6 blanket washes:* • Fair performance. • Cut ink well, but oily residue was difficult to remove. • Extra waste sheets required to get back up to color because of residue.
Baseline Wash at Facility 6	1.5 (n=1)	NA	2	NA	NA	Low	NA	• Good performance. • Cut the ink well without extra effort.
WASH 21 at Facility 17	1.6 ± 0.4 (n=25)	1.8 ± 0.4	2.1 ± 0.4	NA	Low	Medium	NA	*Based on a sample size of 25 blanket washes:* • Fair performance • Oily residue caused print problems if it was not completely removed. • Wash did not absorb into shop towel easily.
Baseline Wash at Facility 17	1.5 ± 0.4 (n=5)	1.3 ± 0.5	1.0 ± 0.0	NA	Medium	Medium	NA	• Good performance • Same effort as standard wash required.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = number of washes on which this data is based, as recorded by the printer.

[b] Time required to clean the blanket measured by the number of blanket rotations: Avg. time per rotation = 20.5 sec. at Facility 6 and 17.1 sec. at Facility 17 (based on time recorded by the observer)

Blanket Wash 22

Composition:
Fatty acids derivatives
Hydrocarbons,aromatic
Water

VOC Content: Not measured
Flashpoint: 157°F (full strength)
pH: 7.4 (25%)

Facility 12

At Facility 12, Wash 22 was used on a 6-unit, 28" x 40" press with conventional inks. A variety of commercial products on a variety of paper types were printed during the performance demonstration: from posters on glossy stock to information cards on cardboard stock. Wash 12 was used approximately thirty times during the week-long performance demonstration. In the typical blanket washing procedure at Facility 12, each blanket is wiped twice: once with a reusable shop towel saturated with blanket wash from a plunger can, and once with a dry reusable shop towel to remove the excess blanket wash. The blanket wash shop towel is often used on more than one blanket, depending on the cleanliness of the shop towel as well as the ink coverage. The standard facility wash is a petroleum naphtha-based product, according to the MSDS. In the performance demonstration, the only change in application procedure was that Wash 22 was directly applied to each shop towel for the application process and the plunger can was not used.

Overall, the performance of Wash 22 was rated as fair. According to press operators, Wash 22 cut the ink well and performed better than the baseline wash overall, but it's thick consistency caused delays while the press operator waited for the wash to soak into the application shop towel. During the initial observation period, the press operator showed great enthusiasm for Wash 22, rating overall performance as good as the standard facility wash and better than the baseline wash in all trials. Over the course of the week, however, the time delays associated with wash application began to weaken the press operator approval for Wash 22. The difficulty in saturating the wash shop towel may have been due to the squirt bottle application device used in the performance demonstration. The use of a plunger might have decreased the wash application time.

At Facility 12, Wash 22 removed the ink with low or medium effort on all ink coverages and, on average, outperformed the baseline wash. The number of rotations required to wash the blanket (proportional to the amount of time) did not increase dramatically from one ink coverage to another. Wash 22 did not leave streaks or residue on the blanket after wiping with a dry shop towel in the standard procedure. There was no change in print quality attributed to the wash. The wash did not perform as well with metallic inks as it did with conventional inks, however. When used on metallic inks, both the effort required to wash the blanket and the amount of wash required increased.

Facility 13

Facility 13 used Wash 22 on a 2-unit, 20" x 26" press during the performance demonstration. Performance demonstration print jobs were primarily folders and brochures printed with light conventional ink coverage on glossy enamel paper. The blanket washing procedure at this facility involves two disposable paper shop towels: one is saturated with blanket wash from a squirt bottle and used to clean the blanket; the other is used dry to remove excess wash and dry the blanket. During this process, the blanket is rotated incrementally under manual

control. The standard application method was not changed for the performance demonstrations.

Overall, press operators rated Wash 22 as a fair performer on the good-fair-poor scale. The baseline and standard washes cut the ink well and were given good performance ratings. Wash 22 cut the ink as well as the baseline and standard washes, but its thick consistency caused delays at the wash application and drying stages. At the blanket wash application stage, the viscous Wash 22 required extra time to soak into the application shop towel before blanket cleaning could begin. After blanket cleaning, Wash 22 left the blanket slightly streaked and wet. Press operators recognized that extra time was necessary to allow excess wash to evaporate and to avoid potential print quality problems. As an indication of this, the number of rotations needed to clean the blanket (considered proportional to the overall time required to wash the blanket) was four times greater for Wash 22 than with the baseline wash. A contributing factor to both of these delays may have been the type of disposable shop towel used by Facility 13 for blanket washing and other press cleaning activities. These disposable paper shop towels were clearly less absorbent than reusable alternatives. The excess wash remaining on the blanket was allowed to evaporate because the disposable shop towels were not absorbent enough to remove it. Overall, press operators at Facility 13 rated the ink cutting ability of Wash 22 as the same as the baseline and standard washes, but felt that the delays in the wash process resulted in greater overall effort and a fair performance rating.

Summary of Performance Demonstrations for Blanket Wash 22

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 22	Not measurable; 2.17%[a]	157	7.4[b]	<1 @ 68°F	1.5	1.5	13	13
Baseline Wash	6.2; 100%	50	6.6	15 @ 100°F	1.5	3	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[d] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 22 at Facility 12	4.4 ± 0.6 (n=5)[c]	2.7 ± 1.2	3.0 ± 0.0	4.0 ± 0.0	Low	Medium	Medium	*Based on a sample size of 5 blanket washes:* • Cut ink as well as baseline wash. • Did not readily soak into shop towel, creating delays. • Fair performer overall.
Baseline Wash at Facility 12	4.4 ± 1.6 (n=6)	4.0 ± 0.0	2.5 ± 1.0	NA	High	High	NA	• Required slightly higher effort than standard wash. • Good performer.
WASH 22 at Facility 13	3.4 ± 1.7 (n=17)	4.0 ± 0.0	2.5 ± 1.6	NA	Medium	Medium	NA	*Based on a sample size of 17 blanket washes:* • Difficult to apply due to thick consistency. • Left blanket slightly streaked and wet, extra drying time necessary to prevent print quality problems. • A fair performer: cut ink well, but required greater effort than baseline.
Baseline Wash at Facility 13	2.1 ± 0.5 (n=4)	1.0 ± 0.0	1.0 ± 0.0	NA	Medium	High	NA	• Cut ink well, a good performer. • Dried quickly on blanket.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] VOC content in lbs/gal was not measurable; % by weight VOC was reported by manufacturer.

[b] 25%

[c] n = number of washes on which this data is based, as recorded by the printer.

[d] Time required to clean the blanket measured by the number of blanket rotations. Avg. time per rotation = 27.5 sec. at Facility 12 and 105.0 sec. at Facility 13

Blanket Wash 24

Composition:
Terpenes
Ethylene glycol ethers
Ethoxylated nonylphenol
Alkyl benzene sulfonates
Alkali/salts
Water

VOC Content: 19%; 1.5 lbs/gal
Flashpoint: 100°F
pH: 9.9

Facility 16

Facility 16 used a 2-unit 20" x 26" press with conventional inks to print advertisements, cards, and other commercial products. The press operator at Facility 16 used Wash 24 for all jobs during the one-week demonstration, with the exception of one job for which there was a concern that the substitute wash would have an effect on the print quality. At this facility, each blanket is typically wiped down three times during cleaning: once with a wet sponge to remove paper dust (when needed); once with a reusable shop towel soaked with naphtha (which is also the baseline wash used throughout the demonstrations); and finally with a clean dry shop towel to remove excess wash. This application procedure was also used for the application of the substitute wash. Facility 16 has tried substitute, low-VOC blanket washes in the past, but found that the products were not acceptable because they did not dry on the blanket as fast as their standard wash.

Overall, the press operator at facility 16 felt that the performance of Wash 24 was "fair". The wash was found to remove the ink well, but a residue was left on the blanket which had an effect on the print quality. Following the manufacturer's instructions, Wash 24 was initially tried at 50% dilution with water. After washing three blankets with the diluted wash, it was apparent that it was not adequately cutting the ink. The baseline wash was found to cut the ink well, but required additional effort due to its resistance to the blanket surface. At full strength, Wash 24 was found to cut the ink with about the same effectiveness as the baseline wash. Wash 24 was tested under light, medium and heavy ink coverage conditions while the baseline wash was observed only under heavy ink coverage conditions. Because the baseline wash is normally used at the facility, the operator's familiarity with the baseline wash allowed him to make accurate comparisons between the substitute wash and the baseline wash under all ink coverage conditions. Under heavy ink coverage conditions, Wash 24 was observed to match the baseline level of performance as measured by blanket rotations. Under light and medium ink coverage conditions, however, Wash 24 was found to require slightly more time than the baseline wash. Overall, the level of effort was rated as "medium" for the substitute wash and "low" for the baseline wash. The press operator considered the effort to be higher than the baseline wash because the substitute wash required extra effort to remove as much of an oily residue as possible and because the thick consistency of the product made it difficult to get it to soak into the shop towel. Most importantly, however, was that this oily residue consistently increased the number of copies needed to return to print quality after restarting the press. Some of this residue would remain on the blanket even after wiping it with a clean dry shop towel.

Facility 17

At Facility 17, Wash 24 was used on a 2-unit, 19" x 26" press with conventional inks to print commercial products such as advertisements and brochures. Facility 17 operates two shifts per day, however, Wash 24 was tested by only one press operator during the first shift. The press operator used Wash 24 for two days and then stopped because he found the amount of effort required to use the substitute wash to be unacceptable. The press operator typically cleans the blankets by going over the blanket once with a shop towel soaked with blanket wash, and then allowing the blanket to dry by evaporation. Occasionally the operator will mix the wash with water to remove paper dust and paper lines from the blanket. Currently, this facility cleans their blankets using a product which consists of petroleum naphtha, dichloromethane and 1,1,1 trichloroethane, according to the MSDS.

Overall, the performance of Wash 24 was considered "poor" by the press operator. Although the product was observed to cut the ink with about the same effectiveness as the baseline wash, it had a thick consistency and left an oily residue, both of which required additional time and effort to clean the blanket. The press operator found the baseline wash to cut the ink well, but some extra effort was required to drag the wash soaked shop towel across the blanket compared to the substitute wash. Wash 24 was demonstrated on blankets with medium ink coverage only. The press operator found that under these conditions the substitute wash required more than twice the number of rotations as the baseline wash, due to the extra steps needed to remove the oily residue using a clean dry shop towel. At this facility, one rotation of the blanket typically took 24.6 seconds, so on average the substitute wash required an extra 37 seconds of cleaning time. Most important to the operator, however, was that the thick consistency of the substitute product made it very difficult to get the product to soak into the shop towel which increased the overall effort to clean the blankets and resulted in significant amounts of wash spilling on the floor and press. The quantity of wash used was about the same for both the substitute wash and the baseline wash. In addition, the press operator was bothered by the strong citrus odor of Wash 24.

Summary of Performance Demonstrations for Blanket Wash 24

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 24	1.5; 19%	100	9.9	<1 @ 25°F	1.5	3.0	15	12
Baseline Wash	6.2; 100%	50	6.6	15 @ 100°F	1.5	3.0	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 24 at Facility 16	2.2 ± 0.6 (n=28)[a]	3.1 ± 1.0	3.0 ± 0.0	3.0 ± 0.0	Medium	Medium	Medium	*Based on a sample size of 28 blanket washes:* • Cut ink well, but some extra effort was required to wipe off oily residue. • Oily residue significantly increased the number of copies required to return to print quality.
Baseline Wash at Facility 16	2.0 ± 0.0 (n=3)	NA	NA	3.0 ± 0.0	NA	NA	Low	• Baseline wash was also the facility's standard wash.
WASH 24 at Facility 17[c]	1.3 ± 0.6 (n=4)	NA	2.5 ± 0.6	NA	NA	High	NA	*Based on a sample size of 4 blanket washes:* • Cut ink well. • Extra effort to wipe off oily residue. • Thick consistency of wash caused operator to curtail use. • Citrus odor was very strong to operator.
Baseline Wash at Facility 17	1.5 ± 0.4 (n=5)	1.3 ± 0.5	1.0 ± 0.0	NA	Medium	Medium	NA	• Good performance; cut ink well. • Extra effort was required due to resistance to drag across blanket.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = number of washes on which this data is based, as recorded by the printer. [c]Based on observer's data; printer data not received.

[b] Time required to clean the blanket measured by the number of blanket rotations. Avg. time per rotation = 21.1 sec. at Facility 16 and 24.6 sec. at Facility 17 (based on time recorded by the project observer)

Blanket Wash 26

Composition:
Fatty acids derivatives
Esters/lactones

VOC Content: 18%; 1.3 lbs/gal
Flashpoint: 230+°F
pH: 7.8 (fluctuates wildly)

Facility 5

At Facility 5, Wash 26 was used on a single-unit, 12" x 18" press to print commercial products such as business cards and advertisements with conventional inks. Facility 5 has tried a variety of substitute blanket washes donated by suppliers but has never adopted one due to performance and cost issues. Currently, this facility uses two different blanket washes. According to the product MSDSs, one wash contains aliphatic hydrocarbons, cyclohexane, n-heptane, methylcyclohexane, toluene, C_6-C_8 paraffins, and C_6-C_8 cycloparaffins) and the other wash contains aromatic hydrocarbons, aliphatic hydrocarbons, 1,2,4-trimethylbenzene, xylene, dipropylene glycol methyl ether, and propylene glycol methyl ether. Typically, the blanket is wiped down twice during cleaning: once with blanket wash to remove the ink, and once with a clean, dry shop towel to remove excess wash. Blanket wash is applied directly to the blanket using a squirt bottle and is then wiped off using a reusable shop towel. The same shop towel is used until it has too much ink build-up to effectively clean the blanket. This application procedure was modified slightly for the baseline wash and substitute wash demonstrations in that the wash was poured onto the shop towel instead of directly on the blanket.

Wash 26 was comparable in performance effectiveness to both the baseline wash and the standard wash used by Facility 5. Wash 26 earned a performance designation of good for every blanket on which it was used during the week-long performance demonstration. The baseline and facility standard washes also received good performance ratings. The effort required to wash the blanket for both the baseline and substitute washes was described as moderate by the press operator. The time required to wash the blanket (as measured by number of rotations) was roughly equal to the baseline wash. Wash 26 cut the ink well across all ink coverages, but left a slight oily residue on the blanket after the initial blanket wiping with wash. This oily residue was removed at the dry wipe step of the blanket washing process and did not cause print quality problems. However, this oily residue did cause problems when Wash 26 was used to wash the press rollers. When used on rollers, the oily residue caused ink splotches to occur. This resulted in time delays during the full press wash procedure as two products were necessary: the standard facility wash for roller cleaning and Wash 26 for blanket cleaning. The press operator commented that the use of the same product for both roller and blanket cleaning is an important cost and effort consideration for his facility.

Facility 15

Facility 15 prints commercial products (brochures), direct-mail products, and other publications. Performance demonstrations at this facility were conducted on a two-unit, 19" x 25" press using conventional inks. The standard wash contains aromatic hydrocarbons, polyglycol ether, and aliphatic hydrocarbons (as stated on the MSDS) and, according to the press operator, cuts the ink well, but does have somewhat of an odor. In the past, Facility 15 tried an alternative blanket wash, but it did not work well and it had a very offensive odor. Recently, this facility installed a new press with an automatic blanket washer. In their standard manual blanket washing procedure, the press operator at this facility pours the blanket wash on to a reusable shop

towel, wipes the ink off the blanket in one rotation, then uses a dry shop towel for one rotation to remove the excess wash. This same procedure was used for both the baseline and the substitute wash.

Wash 26 performed as well as the baseline wash and the standard wash used by Facility 15. Wash 26 received a performance rating of good on the good-fair-poor scale from the press operator after every one of its 22 trials in the week-long performance demonstration. The time required to wash the blankets (as measured by the number of rotations) was equal to the baseline wash. The physical effort required to clean the blanket was described as low for all ink coverages. Over the course of the performance demonstration, Wash 26 did not leave a residue on the blanket and did not affect print quality. The press operator who conducted the performance demonstration stated that Wash 26 would be purchased by his facility if appropriately priced, as well as beneficial from an environmental, worker health, and safety standpoint.

Summary of Performance Demonstrations for Blanket Wash 26

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 26	1.3; 18%	230+	7.8	<1 @ 77°F	0	0	6	14
Baseline Wash	6.2; 100%	50	6.6	15 @ 100°F	1.5	3	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[c] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 26 at Facility 5	0.5 ± 0.1 (n=14)[b]	2.0 ± 0.0	2.3 ± 0.7	NA	Low	Medium	NA	*Based on a sample size of 14 blanket washes:* • Good performance rating after every wash. • Performed as well as both standard facility wash and baseline wash. • Slight oily residue caused print quality problems when wash was used for roller clean-up.
Baseline Wash at Facility 5	1.0 (n=1)	2.0 ± 0.0	NA	NA	Medium	NA	NA	• Cut ink satisfactorily.
WASH 26 at Facility 15	0.7 ± 0.1 (n=22)	2.0 ± 0.0	2.0 ± 0.0	2.0 ± 0.0	Low	Low	Low	*Based on a sample size of 22 blanket washes:* • Good performance rating after every wash. • Performed as well as standard facility wash and baseline wash.
Baseline Wash at Facility 15	1.5 ± 0.7 (n=2)	2.0 ± 0.0	NA	NA	Low	NA	NA	• Cut ink well. • Low effort required. • Good performance rating.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] pH fluctuates

[b] n = number of washes on which this data is based, as recorded by the printer.

[c] Time required to clean the blanket measured by the number of blanket rotations: Avg. time per rotation = 60.0 sec. at Facility 5 and 30.0 sec. at Facility 15 (based on time recorded by the project observer)

Blanket Wash 29

Composition:
Fatty acid derivatives

VOC Content: 30%; 2.1 lbs/gal
Flashpoint: 230+°F
pH: 7.2

Facility 7

At Facility 7, Wash 29 was used on a single-unit 20" x 26" press with conventional inks to print commercial products such as brochures and advertisements. The press operator cleaned only one blanket using Wash 29 after the observer left, and then stopped the demonstration because the substitute wash was found to leave an unacceptable, thick, oily film on the blanket. The following information is, therefore, based on the observer data. At this facility, each blanket is typically wiped down two times during cleaning: once to remove the ink with a reusable shop towel soaked with blanket wash, and once with a clean, dry shop towel to remove excess wash. Blanket wash is applied to the shop towel using a squirt bottle and the shop towel is resoaked with wash prior to reuse on other blankets. The same shop towel is used until it has too much ink build-up to effectively clean the blanket. The standard blanket wash at Facility 7 contains petroleum distillates, 2-butoxyethanol and a proprietary surfactant, according to the MSDS.

Based on the four blanket cleanings with Wash 29, the press operator at Facility 7 found its performance to be "poor". The baseline wash was observed to perform well; cutting the ink well and drying quickly. Although the press operator felt that Wash 29 cut the ink with about the same effectiveness as the baseline wash, the product was very oily, would not dry off of the operator's hands and left an oily residue on the blanket that was very difficult to remove. Additional time and effort were needed to remove as much of the residue as possible using a clean dry shop towel, but some of the oily film was still present after this procedure. Although no difference was noticed between the time to clean the blankets using the baseline wash and Wash 29, the level of physical effort needed to wash the blanket was rated as "high" for the substitute wash compared to "medium" for the baseline wash. The oily film from Wash 29 was observed to slightly increase the number of copies required to return to acceptable print quality after restarting the press. The thick oily consistency of the product also increased overall effort because it made it difficult to get the wash to soak into the shop towel. The press operator did notice, however, that the smell of the product was not as strong as the baseline wash or the facility's standard wash.

Facility 8

Facility 8 used a 6-unit 20" x 26" press with conventional inks to print brochures, advertisements and other commercial products. The press operator at Facility 8 used Wash 29 for all jobs during the one-week demonstration. At this facility, each blanket is typically wiped down two times during cleaning: once with a reusable shop towel saturated with blanket wash, and once with a clean dry shop towel to remove excess wash. The saturated shop towel is typically used to clean all six blankets on the press before being resaturated or sent out for laundering. This application procedure was also used for the application of the baseline wash and the substitute wash. Facility 8 was using a wash which contains aliphatic petroleum distillates, aromatic petroleum distillates, xylene, 2-butoxy ethanol, methylene chloride, diacetone alcohol, diisononyl phthalate, 2,6-di-tert-butyl-p-cresol, ethylbenzene and 1,2,4 trimethylbenzene (according to the MSDS) to clean the blankets prior to and following the blanket wash demonstration. Alternative low-VOC blanket wash were experimented with in the past, but they did not cut the ink well, did not dry fast and left and oily residue on the blanket.

The press operator at Facility 8 evaluated the performance of Wash 29 as "poor". The operator found that Wash 29 did not cut the ink as well as the baseline product and did not remove paper dust and powder. The baseline product was observed to cut the ink well and dry quickly, but required some extra effort to drag it across the blanket surface. Using Wash 29, more time and much more effort were needed to remove the ink than was needed with the baseline product. Under medium ink coverage conditions, the average number of rotations required to clean the blanket using Wash 29 was 4.0 compared to 2.7 for the baseline wash. Because the average time to rotate a blanket was 15.5 seconds at facility 8, the average blanket cleaning time increased by 20 seconds under medium ink coverage conditions over the baseline wash. The press operator rated the effort needed to clean the blankets using both the baseline wash and Wash 29 as "high" under medium ink coverage conditions due to the extra time needed to remove the ink. The effort to use the baseline wash was rated as "high" because the operator found it to have high resistance when dragging it across the blanket and the effort to use the substitute wash was rated as "high" due to the extra rotations needed to remove the ink. The substitute wash was also observed to leave a slight oily film on the blanket, but no effect was observed on the print quality. The press operator noticed that the substitute wash's odor was agreeable and not too strong.

Summary of Performance Demonstrations for Blanket Wash 29

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 29	2.1; 30%	230+	7.2	<1 @ 68°F	1.5	1.5	9	18
Baseline Wash	6.2; 100%	50	6.6	15 @ 100°F	1.5	3.0	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 29 at Facility 7[c]	1.0 ± 0.0 (n=3)	NA	2.0 ± 0.0	NA	NA	High	NA	*Based on a sample size of 3 blanket washes:* • Good performance; cut ink well. • Extra effort was required to dry the blanket.
Baseline Wash at Facility 7	1.2 ± 0.0 (n=2)	NA	2.0 ± 0.0	NA	NA	Medium	NA	• Good performance; cut ink well.
WASH 29 at Facility 8	0.8 ± 0.6 (n=36)	4.1 ± 0.8	4.0 ± 0.0	NA	Medium	High	NA	*Based on a sample size of 36 blanket washes:* • Did not cut ink as well as baseline wash. • Did not cut paper dust or powder. • More effort was required to remove slight oily film on blanket.
Baseline Wash at Facility 8	0.7 ± 0.0 (n=4)	NA	2.7 ± 0.5	NA	NA	High	NA	• Good performance; cut ink well. • Extra effort was required due to resistance to being dragged across the blanket.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = number of washes on which this data is based, as recorded by the printer.

[b] Time required to clean the blanket measured by the number of blanket rotations. Avg. time per rotation = 27.5 sec. at Facility 7 and 15.5 sec. at Facility 8 (based on time recorded by the project observer)

[c] Based on observer's data; printer data not received.

Blanket Wash 30

Composition:
Hydrocarbons, aromatic
Propylene glycol ethers
Water

VOC Content: 7%; 0.48 lbs/gal
Flashpoint: 100°F (full strength)
pH: 7.6 (25%)

Facility 18

At Facility 18, Wash 30 was used on a single-unit 20" x 30" press and a 2-unit, 19" x 26" press with soy oil-based inks and commercial products such as business forms and brochures were printed. The press operator used Wash 19 for the four days that the presses were operating during the one-week demonstration period which resulted in only three blanket cleanings. At this facility, each blanket is typically wiped down three times during cleaning: twice with a reusable shop towel soaked with blanket wash, and once with a dry shop towel to remove excess blanket wash. Blanket wash is applied to the shop towel using a squirt bottle and the shop towel is resoaked with wash prior to reuse on other blankets. The same shop towel is used until it has too much ink build-up to effectively clean the blanket. Currently, this facility cleans their blankets using a product which contains aliphatic hydrocarbons, according to the MSDS. Other than changing the number of rotations to clean a blanket, this application procedure was not modified during the demonstration of the substitute product. Facility 18 had tried an alternative low-VOC blanket wash, but found that it did not dry as fast as their standard product and was more expensive.

Based on the three blanket cleanings with Wash 30, the press operator at Facility 18 evaluated its performance as "fair". The baseline wash was found to cut the ink well, but required additional effort due to the wash's high resistance to the blanket surface. Wash 30 was only tested under heavy ink coverage conditions and the baseline wash was observed under light and medium coverage conditions. The substitute wash was observed to require about the same amount of time as measured by blanket rotations under heavy ink coverage conditions as the baseline wash required under medium coverage conditions. The press operator found that Wash 30 cut the ink well and overall it performed with about the same effectiveness as the baseline wash. Following the manufacturer's instructions, the substitute wash was tried with 25% dilution with water, but was found to perform better at full strength. The press operator rated the effort needed to clean a blanket with heavy ink coverage as "medium". Although the baseline wash was not tested under those conditions, the operator felt that the amount of physical effort needed to clean the blanket with Wash 30 would be about the same as that of the baseline wash. The press operator also observed that when accidentally spilled on a clear plastic guard on the press, Wash 30 permanently clouded the plastic, necessitating its replacement.

Facility 19

Facility 19 used a 2-unit 19" x 26" press also with soy oil-based inks to print brochures, cards, and other commercial products. The press operator at Facility 19 used Wash 30 for the entire one-week demonstration. The operator typically cleans the blanket by pouring the blanket wash onto a clean, reusable shop towel and wiping the blanket while rotating it manually twice. The blanket is then allowed to dry by evaporation before restarting the press. This application procedure was also used for the application of the baseline wash. When using Wash 30, the press

operator modified the application procedure slightly and wiped the blanket with a dry shop towel before resuming the print job. The standard wash used at this facility contains aromatic hydrocarbons, polyglycol ethers, aliphatic hydrocarbons, and a proprietary combustible chemical. Prior to this project, they did some experimenting with another substitute wash, but it did not work as well as their standard product and it was irritating to the skin as well. In the past, they used an automatic blanket washer, hoping to reduce their blanket wash chemical use and labor, but they discontinued using it after they found it required more effort and wasted solvent.

The press operator at Facility 19 evaluated the performance of Wash 30 as "fair". The substitute product was found to cut the ink well, but required additional effort because the substitute wash did not evaporate off of the blanket quickly and needed to be wiped off with a clean dry shop towel and the product's thick consistency made it difficult and "messy" to use. The baseline wash was found to cut the ink well, but required additional effort due to the wash's high resistance to the blanket surface. On average, about one extra rotation of the blanket was required with the substitute wash compared to the baseline wash due to the additional step needed to dry the blanket. Because the average time to rotate a blanket was 18.5 seconds at facility 19, the increase in blanket cleaning time was not substantial. The press operator rated the effort needed as "high" for both the baseline and the substitute washes. The effort needed to use the substitute wash was rated as "high" due to the additional drying step, difficulty in getting the wash to soak into a shop towel, and because the operator found it had a slight resistance to the blanket surface. The effort to use the baseline wash was rated as "high" because the operator found the baseline wash had unusually high resistance to the blanket surface. An oily film was noticed on the blanket after using Wash 30, but the operator felt that the film had only a slight effect on the number of copies needed to get back to print quality after restarting the press.

Summary of Performance Demonstrations for Blanket Wash 30

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 30	0.48; 7%	100	7.6	2.2 @ 68°F	0.7	1.5	5	11
Baseline Wash	6.2; 100%	50	6.6	15 @ 100°F	1.5	3	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 30 at Facility 18	4.0 ± 0.0 (n=3)[a]	NA	NA	3.3 ± 0.6	NA	NA	Medium	*Based on a sample size of 3 blanket washes:* • Good performance; cut ink well. • Worked best with no dilution with water.
Baseline Wash at Facility 18	1.5 ± 0.8 (n=6)	2.7 ± 0.5	3.5 ± 0.7	NA	Low	Low	NA	• Good performance; cut ink well.
WASH 30 at Facility 19	0.7 ± 0.0 (n=8)	3.0 ± 0.0	3.0 ± 0.0	NA	High	High	NA	*Based on a sample size of 8 blanket washes:* • Cut ink well. • Required extra effort to dry oily film from blanket. • Thick consistency was difficult to use. • Extra effort was required due to resistance to surface of the blanket.
Baseline Wash at Facility 19	0.9 ± 0.2 (n=5)	2.2 ± 0.4	NA	NA	High	NA	NA	• Good performance; cut ink well. • Extra effort was required due to resistance to surface of the blanket.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = number of washes on which this data is based, as recorded by the printer.

[b] Time required to clean the blanket measured by the number of blanket rotations: Avg. time per rotation = 16.2 sec. at Facility 18 and 18.5 sec. at Facility 19 (based on time recorded by the project observer)

Blanket Wash 31

Composition:
Hydrocarbons, aromatic
Hydrocarbons, petroleum distillates

VOC Content: 99%; 6.6 lbs/gal
Flashpoint: 105°F
pH: 7.6

Facility 7

At Facility 7, Wash 31 was used on a single-unit 20" x 26" press with conventional inks to print commercial products such as brochures and advertisements. The press operator at Facility 7 used Wash 31 for all jobs during the one-week demonstration which resulted in only 4 cleanings. At this facility, each blanket is typically wiped down two times during cleaning: once to remove the ink with a reusable shop towel soaked with blanket wash, and once with a clean, dry shop towel to remove excess wash. Blanket wash is applied to the shop towel using a squirt bottle, and the shop towel is resoaked with wash prior to reuse on other blankets. The same shop towel is used until it has too much ink build-up to effectively clean the blanket. The standard blanket wash at Facility 7 contains petroleum distillates, 2-butoxyethanol and a proprietary surfactant, according to the MSDS.

The press operator at Facility 7 evaluated Wash 31 as "fair". Wash 31 was observed to cut the ink well, but did not dry as fast as the baseline wash. The baseline wash was observed to perform well; cutting the ink well and drying quickly. Although not reflected in the data, the operator felt that some additional time and effort were needed to remove the excess wash using a clean, dry shop towel. Under medium ink coverage conditions, no difference was noticed between the time to clean the blankets as measured by the number of rotations using the baseline wash or Wash 31. However, the level of physical effort needed to wash the blanket was rated as "high" for the substitute wash compared to "medium" for the baseline wash. The press operator noticed that the smell of the substitute wash was noticeable, but not disagreeable.

Facility 8

Facility 8 used a 6-unit 20" x 26" press with conventional inks to print brochures, advertisements and other commercial products. The press operator at Facility 8 used Wash 31 for all jobs during the one-week demonstration. At this facility, each blanket is typically wiped down two times during cleaning: once with a reusable shop towel saturated with blanket wash, and once with a clean dry shop towel to remove excess wash. The saturated shop towel is typically used to clean all six blankets on the press before being resaturated or disposed. This application procedure was also used for the application of the baseline wash and the substitute wash. Facility 8 was using a product containing aliphatic petroleum distillates, aromatic petroleum distillates, xylene, 2-butoxy ethanol, methylene chloride, diacetone alcohol, diisononyl phthalate, 2,6-di-tert-butyl-p-cresol, ethylbenzene and 1,2,4 trimethylbenzene, according to the MSDS, to clean the blankets prior to and following the blanket wash demonstration. Alternative low-VOC blanket washes were experimented with in the past, but they did not cut the ink well, did not dry fast, and left an oily residue on the blanket.

Overall, the performance of Wash 31 was considered "good/fair". Wash 31 was tested under light, medium and heavy ink conditions, while the baseline wash was observed only under medium

coverage conditions. The press operator observed that the wash cut the ink well, dried quickly and performed about as well as the baseline wash. Under medium coverage conditions, it was observed that the substitute wash required less time to clean the blankets than the baseline wash. Somewhat more of Wash 31 was needed, however, to remove the ink in comparison to the baseline wash (0.7 ounces for the baseline wash compared to 1.1 ounces for the substitute wash). The press operator rated the effort needed to clean the blankets using Wash 31 as "low" under all coverage conditions, although he did note that there was slightly more resistance to the blanket surface. The effort needed to use the baseline wash was rated as "high" because the operator found it to have unusually high resistance to the blanket.

Summary of Performance Demonstrations for Blanket Wash 31

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 31	6.6; 99%	105	7.6	<0.1 @ 68°F	1.5	3.0	3	3
Baseline Wash	6.2; 100%	50	6.6	15 @ 100°F	1.5	3.0	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 31 at Facility 7	1.5 ± 0.6 (n=4)[a]	2.0 ± 0.0	2.0 ± 0.0	NA	High	High	NA	*Based on a sample size of 4 blanket washes:* • Cut the ink well; slightly more effort needed to remove oily residue on blanket. • Oily residue slightly increased the copies required to return to print quality. • Smell not as strong as facility's standard wash or baseline wash.
Baseline Wash at Facility 7	1.2 ± 0.0 (n=2)	NA	2.0 ± 0.0	NA	NA	Medium	NA	• Good performance; cut ink well.
WASH 31 at Facility 8	1.1 ± 1.5 (n=61)	2.0 ± 0.0	2.0 ± 0.0	2.1 ± 0.2	Low	Low	Low	*Based on a sample size of 61 blanket washes:* • Good performance; cut ink well • Performed as well as standard wash. • Slightly more effort was required due to resistance to surface of the blanket.
Baseline Wash at Facility 8	0.7 ± 0.0 (n=4)	NA	2.7 ± 0.5	NA	NA	High	NA	• Good performance; cut ink well. • Extra effort was required due to resistance to the surface of the blanket.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = number of washes on which this data is based, as recorded by the printer.

[b] Time required to clean the blanket measured by the number of blanket rotations: Avg. time per rotation = 82.5 sec. at Facility 7 and 17.1 sec. at Fac. 8 (based on time recorded by the observer)

Blanket Wash 32

Composition:
Hydrocarbons, petroleum distillates

VOC Content: 99%; 6.5 lbs/gal
Flashpoint: 220°F
pH: 8.5

Facility 1

At Facility 1, performance demonstrations were conducted on an eight-unit, 28" x 40" press using vegetable-based inks to print high quality, multi-color, commercial products. Currently, Facility 1 uses a blanket wash which consists of aromatic hydrocarbons, 1,2,4-trimethylbenzene, and aliphatic hydrocarbons, according to the MSDS. In the months preceding the demonstrations, the facility had tried two different low-VOC blanket washes; neither worked as well as their standard wash. At this facility, each blanket is typically wiped down twice during cleaning: once with a reusable shop towel saturated in blanket wash to remove the ink, and once with a dry shop towel to remove excess blanket wash. Each saturated shop towel is used to clean two blankets. The same application procedure was used for the baseline and substitute products. The quantity of wash needed to saturate the shop towel and clean the blanket remained constant throughout the demonstration, regardless of the ink coverage or ink build-up on the blanket. There were both positive and negative aspects to this application method. While more wash than was needed may have been used in some cases, the consistency of the application volume made it possible to compare the performance of the standard, baseline, and substitute products under the same conditions.

Overall, the performance of Wash 32 was considered "fair/poor." Although it cut the ink well, more effort was required than with the baseline wash. When using the baseline wash, the operator found it cut it the ink well, but required some more effort than their standard wash. The additional effort to clean the blanket with Wash 32 was needed to remove the oily residue that remained on the blanket. With Wash 32, an average of 4 rotations (approximately 80 seconds) were needed to clean the blanket, whereas with the baseline product, only 2 rotations (40 seconds) were required. After using Wash 32, the residue persisted, even after wiping down the blanket with two dry wipes. The press operator commented that normally a slight residue may not be a problem, but in this case, it caused problems with future print quality. On subsequent images, there was visible "chatter" (faint, inconsistent lines where the color is supposed to be uniformly solid) on the print. Eventually, the residue is picked up in the prints and the chatter is only a temporary problem, however, more impressions are needed to get back up to acceptable quality than with the standard or baseline wash. After eight blanket cleanings (four with the observer present and four more conducted by the printer), Facility 1 decided to discontinue the performance demonstration with Wash 32.

Facility 5

At Facility 5, performance demonstrations were conducted using a single-unit, 12" x 18" press with conventional inks to print commercial products such as business cards and advertisements. According to the MSDSs, this facility currently uses either a blanket wash which contains aliphatic hydrocarbons, cyclohexane, n-heptane, methylcyclohexane, toluene, C_6-C_8 paraffins, and C_6-C_8 cycloparaffins or one that consists of aromatic hydrocarbons, aliphatic hydrocarbons, 1,2,4-trimethylbenzene, xylene, dipropylene glycol methyl ether, and propylene glycol methyl ether. Facility 5 has tried several substitute blanket washes that were donated by

their supplier. None of these products were adopted either because they did not work as well as their standard wash (left an oily residue on the blanket) or they were too expensive (up to twice as much as their standard wash). The facility has reduced the quantity of solvent used by reusing the drying shop towel from the previous wash for the application of blanket wash in the subsequent blanket wash procedure. This reduced the amount of solvent used, the number of shop towels sent to the laundry and the associated laundering costs, and the environmental impacts such as laundry wastewater and energy usage. Typically, the blanket is wiped down twice during cleaning: once with blanket wash to remove the ink, and once with a clean, dry shop towel to remove excess wash. Blanket wash is applied directly to the blanket using a squirt bottle and is then wiped off using a reusable shop towel. The same shop towel is used until it has too much ink build-up to effectively clean the blanket. This application procedure was modified slightly for the baseline wash and substitute wash demonstrations in that the wash was poured onto the shop towel instead of directly on the blanket.

Wash 32 was used for one week and 12 washes were recorded by the press operator. Overall, the performance of Wash 32 was rated "good." When compared to the baseline wash (which cut the ink well and cleaned the blanket as well as their standard wash), the effort needed to clean the blanket with Wash 32 was slightly higher because Wash 32 left an oily residue on the blanket. With the baseline or the standard wash, one rotation with a dry shop towel was enough to remove the excess wash. With Wash 32, two or three rotations with the dry wipe were required. On average, the drying time increased from approximately 21 seconds using the baseline or standard wash to approximately 32 seconds using Wash 32. This extra drying step increased the effort required, however, the residue did not affect future print quality. The printer commented that the slight residue came off quickly during the normal waste sheet portion of the next run.

During the demonstration, Wash 32 was used on light, medium, and heavy ink coverage; all with good results. It should be noted that heavy ink coverage for a business card, is not the equivalent of heavy ink coverage for larger print operations. The printer at Facility 5 felt the oily residue could cause some problems on a bigger press with greater ink coverage.

Summary of Performance Demonstrations for Blanket Wash 32

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 32	6.5; 99%	220 8.5	8.5	<1 @ 68°F	0.1	1.5	5	30
Baseline Wash	6.2; 100%	50 6.6	6.6	15 @ 100°F	1.5	3	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 32 at Facility 1	2.5 ± 0.0 (n=4)[a]	NA	4.2 ± 0.5	NA	NA	High	NA	*Based on a sample size of 4 blanket washes:* • Good performance. • Required slightly higher effort to remove excess wash than with the standard wash.
Baseline Wash at Facility 1	2.5 ± 0.0 (n=2)	2.0 ± 0.0	2.0 ± 0.0	NA	High	High	NA	• Fair/poor performance. • Oily residue caused "chatter" in subsequent prints.
WASH 32 at Facility 5	0.7 ± 0.2 (n=12)	3.0 ± 0.0	3.0 ± 0.0	3.0 ± 0.0	Low	Medium	Medium	*Based on a sample size of 12 blanket washes:* • Good performance. • Left slight, oily residue that was removed with dry shop towels and did not affect print quality.
Baseline Wash at Facility 5	1.0 (n=1)	2	NA	NA	Low	NA	NA	• Good performance. • Cut ink well with same effort as standard wash.

NA = Not Applicable; product was not demonstrated under these conditions.
NC = Not Calculated; VOC content as a % by weight could not be calculated because specific gravity data was not available.
[a] n = number of washes on which this data is based, as recorded by the printer.
[b] Time required to clean the blanket measured by the number of blanket rotations: Avg. time per rotation = 20.0 sec at Facility 1 and 10.6 sec at Facility 5 (based on time recorded by the observer)

Blanket Wash 34

Composition:
Water
Terpenes
Hydrocarbons, petroleum distillates
Alkoxylated alcohols
Fatty acid derivatives

VOC Content: 39%; 2.8 lbs/gal
Flashpoint: 138°F
pH: 6.6

Facility 1

At Facility 1, performance demonstrations were conducted on an eight-unit, 28" x 40" press using vegetable-based inks to print high quality, multi-color, commercial products. Currently, Facility 1 uses a blanket wash which consists of aromatic hydrocarbons, 1,2,4-trimethylbenzene, and aliphatic hydrocarbons, according to the MSDS. In the months preceding the demonstrations, the facility had tried two different low-VOC blanket washes; neither worked as well as their standard wash. At this facility, each blanket is typically wiped down twice during cleaning: once with a reusable rag saturated in blanket wash to remove the ink, and once with a dry rag to remove excess blanket wash. Each saturated rag is used to clean two blankets. The same application procedure was used for the baseline and substitute products. The quantity of wash needed to saturate the rag and clean the blanket remained constant throughout the demonstration, regardless of the ink coverage or ink build-up on the blanket. There were both positive and negative aspects to this application method. While more wash than was needed may have been used in some cases, the consistency of the application volume made it possible to compare the performance of the standard, baseline, and substitute products under the same conditions.

The operator used Wash 34 for one week and cleaned 37 blankets. The wash performance was considered "good;" this facility used five different substitute washes over a two month period for the performance demonstrations project and the press operator considered Wash 34 to be the best performer. During the course of the week, the operator recorded data on the performance of Wash 34 on blankets with all levels of ink coverage. On blankets with light or medium ink coverage, Wash 34 cut the ink well with the same level of effort as was used when cleaning with the baseline or standard wash. For light and medium ink coverage, the operator considered the performance to be "good" for all washes. On blankets with heavy ink coverage, slightly more effort was required than with the standard wash. For the 19 blankets cleaned where ink coverage was heavy, performance was rated as "good" on 12 blankets (63%) and "fair" for 7 blankets (37%). The press operator noticed that the product had a "very dry feel" to it. He found performance and ease of use improved when he wiped the blanket with a sponge soaked with water before applying Wash 34. Wiping the blanket with a wet sponge prior to application of the wash is often done to remove paper build-up, so the printer did not consider this step to be an extra effort.

Performance of Wash 34 was comparable to that of the baseline wash (which cut the ink well, and required the same amount of time as their standard wash, but did require some additional effort to remove the oily residue). Average time required to clean the blanket with the baseline wash was approximately 40 seconds for light or medium ink coverage, and with Wash 34, average cleaning time varied between 40 and 60 seconds.

Facility 19

For the performance demonstrations, Facility 19 used a 2-unit, 19" x 26" press with soy oil-based inks to print brochures, cards, and other commercial products. The standard wash used at this facility contains aromatic hydrocarbons, polyglycol ethers, aliphatic hydrocarbons, and a proprietary combustible chemical, according to the MSDS. Prior to this project, they did some experimenting with another substitute wash, but it did not work as well as their standard product and it was irritating to the skin as well. In the past, they used an automatic blanket washer, hoping to reduce their blanket wash chemical use and labor, but they discontinued using it after they found it required more effort and wasted solvent. Typically, the operator at Facility 19 cleans the blanket by pouring the blanket wash onto a clean, reusable shop towel and wiping the blanket while rotating it manually twice. The blanket is then allowed to dry by evaporation before restarting the press. This application procedure was also used for the application of the baseline wash. When using the substitute Wash 34, the press operator modified the application procedure slightly and wiped the blanket with a dry shop towel before resuming the print job.

This printer considered the performance of Wash 34 to be "fair" or "poor" for light, medium, and heavy ink coverage. Data sheets were completed for 13 blanket washes. The printer found that Wash 34 left a light coating on the blanket, and often "high" effort was needed to remove this residue. The consistency of the wash was another problem: the printer found that the thick consistency of the wash prevented it from soaking into the shop towel easily. Before he could apply the wash, the press operator had to work it into the shop towel, additionally increasing the effort needed to clean the blanket with Wash 34. It took longer to clean the blanket with Wash 34 than with the baseline wash. The baseline wash cut the ink well, but required slightly more effort than their standard wash. Additional effort was due to the increased drag of the shop towel over the blanket; the baseline wash was not as smooth as their standard wash. The printer did note that fewer impressions were needed to get back up to acceptable print quality after cleaning the blanket with the baseline product. When ink coverage was light, the average time to clean the blanket with Wash 34 was approximately 65 seconds; with the baseline wash the average cleaning time was approximately 40 seconds.

Summary of Performance Demonstrations for Blanket Wash 34

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**pH**	**Flashpoint (°F)**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 34	2.8; 39%	6.6	138	2 @ 68°F	1.5	3	10	20
Baseline Wash	6.2; 100%	6.6	50	15 @ 100°F	1.5	3	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[c] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 34 at Facility 1	2.5 ± 0.0 (n=37)[a]	2.6 ± 0.6	2.2 ± 0.4	3.1 ± 1.0	Medium	Medium	High	*Based on a sample size of 37 blanket washes:* • Good performance; best of the 5 substitute washes demonstrated at this facility. • Cut the ink well with the same effort as with the standard wash for light/medium ink coverage. • Slightly more effort needed for heavy ink coverage, but acceptable.
Baseline Wash at Facility 1	2.5 ± 0.0 (n=2)	2.0 ± 0.0	2.0 ± 0.0	NA	High	High	NA	• Good performance. • Required slightly more effort than standard wash.
WASH 34 at Facility 19	1.2 ± 0.4 (n=13)[b]	3.6 ± 0.6	4.0 ± 0.0	3.7 ± 0.5	Medium	Medium	High	*Based on a sample size of 13 blanket washes:* • Fair/Poor performance. • Cut the ink well, but did not soak into shop towel and extra effort was needed to remove the oily residue.
Baseline Wash at Facility 19	0.9 ± 0.2 (n=5)	2.2 ± 0.4	NA	NA	High	NA	NA	• Good performance. • Fewer impressions were needed to get back to acceptable print quality than with standard wash.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = # of washes recorded by the printer;

[b] n = # of washes recorded by the observer.

[c] Time required to clean the blanket measured by the number of blanket rotations: Avg. time per rotation = 20.0 sec at Facility 1 (measured by the observer); 18 sec at Facility 19 (estimated).

Blanket Wash 37

Composition:
Water
Hydrocarbons, petroleum distillates
Hydrocarbons, aromatic

VOC Content: 14%; 1.0 lbs/gal
Flashpoint: 82°F
pH: 3.9

Facility 3

Facility 3 used Wash 37 on a 2-unit, 18" x 25" press, with conventional inks to print a variety of commercial products. Facility 3 had used a new blanket wash for health, safety or environmental reasons on one occasion prior to the performance demonstration. The wash had not been adopted because it left an oily residue on the blanket and took too long to dry. Normal blanket washing procedure is the following: a squirt bottle is used to apply blanket wash to a reusable shop towel, the shop towel is then used to wipe the blanket as it is manually rotated, and the blanket is allowed to air dry. Standard facility blanket wash was a mixture of aliphatic and aromatic hydrocarbons, according to the MSDS. The application procedure was changed for the performance demonstration. Wash 37 did not dry as quickly as the standard facility wash, so a dry shop towel was used to remove the residue from the blanket after the washing step. For each blanket cleaning, the procedure was to apply only a sufficient amount of wash to the shop towel. Press operators increased the amount of Wash 37 applied to the shop towel as ink coverage on the blanket increased.

Press operators had no problems with Wash 37 during the performance demonstration. Wash 37 drying time was slightly greater than for the baseline and standard facility washes, but, according to press operators, Wash 37 performed as well overall. Wash 37 received good and fair performance ratings on light and medium ink coverage print jobs, respectively, as there were no heavy ink coverage jobs during the week of the performance demonstration. According to press operators, medium ink coverage jobs required more effort to clean than light ink coverage jobs with Wash 37. The baseline wash was considered a good performer, although it was only tested on medium coverage print jobs. Due to the addition of the drying step, the use of Wash 37 doubled the time required to wash the blanket (which is proportional to the number of blanket rotations needed), from one, as required with the baseline, to two rotations on average.

Facility 4

Wash 37 was used on a 4-unit, 34" x 40" press at Facility 4 which does most of its business in commercial printing products such as software manuals and calendars. Facility 4 uses a solution of aliphatic hydrocarbons, aromatic hydrocarbons, and surfactants, as the standard blanket wash, according to the MSDS. Blanket wash procedure at Facility 4 consists of a two wipe process. Blanket wash is applied to a clean, dry, and reusable shop towel which is used to wash the blanket. Another clean dry shop towel is then used to remove excess wash and dry the blanket. If ink buildup on the shop towels is not significant, the shop towels are used to wash more than one blanket. If paper coating is deposited on the blanket from the job, the blanket wash shop towel is dipped into a bucket of water before wiping down the blanket. This standard blanket washing procedure was not modified for the performance demonstration.

Initially, Wash 37 performed well at Facility 4. It cut the ink well, soaked into the application shop towel readily, and required little effort. Then, after a few days of usage, Wash 37

caused uncoated paper to stick to the blankets. The tackiness of the blankets was such that uncoated paper stock was pulled apart during the printing process. Facility 4 discontinued its performance demonstration of Wash 37 and the problems disappeared.

Summary of Performance Demonstrations for Blanket Wash 37

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 37	1.0; 14%	82	3.9	2.3 @ 68°F	3	3	5	8
Baseline Wash	6.2; 100%	50	6.6	15 @ 100°F	1.5	3	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 37 at Facility 3	1.3 ± 0.6 (n=17)[a]	2.0 ± 0.0	2.5 ± 0.7	NA	Low	Medium	NA	*Based on a sample size of 17 blanket washes:* • Longer drying time than baseline and standard washes. • Performance rated as good and fair on light and medium coverages, respectively. • Press operators had no problems with wash.
Baseline Wash at Facility 3	1.0 (n=1)	NA	1.0 ± 0.0	NA	NA	Medium	NA	• Good performance: cut the ink well.
WASH 37 at Facility 4	2.2 ± 0.8 (n=6)	NA	2.8 ± 0.4	NA	NA	Medium	NA	*Based on a sample size of 6 blanket washes:* • Worked well initially, but caused paper breakup due to blanket tackiness. • Use of wash discontinued.
Baseline Wash at Facility 4	3.0 ± 0.0 (n=2)	NA	3.0 ± 0.0	NA	NA	Low	NA	• Good performance: cut the ink well. • Slight odor.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = number of washes this data is based on, as recorded by the printer.

[b] Time required to clean the blanket measured by the number of blanket rotations. Avg. time per rotation = 24.0 sec. at Facility 3 and 42.0 sec. at Facility 4 (based on time recorded by the project observer)

Blanket Wash 38

Composition:
Hydrocarbons, petroleum distillates
Alkoxylated alcohols
Fatty acid derivatives

VOC Content: 65%; 4.9 lbs/gal
Flashpoint: 230+°F
pH: 5.6

Facility 2

Facility 2 used a 3-unit, 13" x 18" press for the performance demonstrations. This facility prints commercial products (brochures, flyers, cards) using both conventional and vegetable oil-based inks. The standard blanket wash consists of aromatic hydrocarbons, 1,2,4-trimethylbenzene, and aliphatic hydrocarbons (per the MSDS) which, according to the press operator, cuts the ink well, but does have somewhat of an odor. In the past, Facility 2 has tried two substitute blanket washes: performance was rated as poor ("it did not work at all") for one product, and the other product they tested was too expensive. In their standard blanket washing procedure, the press operator at this facility pours the blanket wash onto a reusable rag from a squirt bottle, wipes the ink off the blanket in one rotation, then uses a dry rag for one rotation to remove the excess wash. This procedure was used for both the baseline and the substitute wash.

The use of Wash 38 was discontinued by Facility 2 after 1.5 days of use due to print problems resulting from an oily residue left on the blanket after the blanket wash process. According to press operators, Wash 38 also required more effort to cut the ink and to wipe the blanket than both the standard wash and the baseline wash of the performance demonstration. Performance was especially poor with heavy ink coverage, but Wash 38 was rated as requiring high effort and demonstrating poor performance after every blanket cleaning at Facility 2. The oily film left on the blanket after using Wash 38 caused a noticeable increase in the number of impressions required to reach acceptable print quality after a wash procedure. Press operators experimented with a variety of ways for removing this residue (e.g., dry wipe, water) but were unable to prevent it from affecting print quality.

Facility 4

Wash 38 was used on a 4-unit, 28" x 40" press at Facility 4 with conventional inks to produce a variety of commercial printing products such as software manuals. Facility 4 uses a solution of aliphatic hydrocarbons, aromatic hydrocarbons, and surfactants (according to the information on the MSDS) as the standard blanket wash. Facility 4 has pursued some work practice changes to reduce its use of blanket wash solution. Instead of saturating rags with wash in a plunger can, press operators at Facility 4 are encouraged to apply an appropriate amount of blanket wash on each rag as needed, which reduces the overall quantity of blanket wash used at the facility. Blanket wash procedure at Facility 4 consists of a two wipe process. Blanket wash is applied to a clean, dry, and reusable rag which is then used to wash the blanket. Another clean dry rag is then used to remove excess wash and dry the blanket. If the rags are clean enough, they are used to wash more than one blanket on the 4-unit press. The press blankets rotate automatically during this process. If a significant amount of paper coating is deposited on the blanket from the job, the blanket wash rag is dipped into a bucket of water before wiping down the blanket. This standard blanket washing procedure was not modified for the performance demonstration.

Wash 38 cut the ink well, but left an oily residue on the blanket that increased the number of impressions required to return print quality by 5 to 10 times above that required with the baseline or standard facility washes. Due to this print quality interference, the press operator returned to the standard facility wash after 6 trials. The press operator attempted to remove the oily residue with a dry wipe, but was unable to remove it completely. The oily residue interfered with ink adhesion, especially with red and yellow inks. According to the press operator, Wash 38 cut the ink well but caused sufficient print quality problems to prevent a facility from adopting it for environmental or worker health and safety reasons. The baseline wash was considered a good performer that cut the ink well. Press operators described the odor of the baseline wash as strong.

Summary of Performance Demonstrations for Blanket Wash 38

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 38	4.9; 65%	230+	5.6	2.0 @ 68°F	0	1.5	9	16
Baseline Wash	6.2; 100%	50	6.6	15 @ 100°F	1.5	3	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 38 at Facility 2	2.2± 0.6 (n=9)[a]	3.0 ± 0.0	NA	5.0 ± 0.0	High	NA	High	*Based on a sample size of 9 blanket washes:* • Oily residue caused print quality problems. • Use of wash discontinued after 1.5 days due to poor performance and print quality problems.
Baseline Wash at Facility 2	1.2 ± 0.8 (n=3)	2.7 ± 1.2	NA	NA	Medium	NA	NA	• Wash cut ink satisfactorily. • Did not leave residue on blanket.
WASH 38 at Facility 4	3.7 ± 1.3 (n=6)	NA	3.0 ± 0.0	3.5 ± 0.6	NA	Medium	High	*Based on a sample size of 6 blanket washes:* • Use of wash discontinued after 6 trials due to print quality problems from oily residue. • Wash cut ink satisfactorily.
Baseline Wash at Facility 4	3.0 ± 0.0 (n=2)	NA	3.0 ± 0.0	NA	NA	Low	NA	• Cut the ink well. • Strong odor.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = number of washes on which this data is based, as recorded by the printer.

[b] Time required to clean the blanket measured by the number of blanket rotations: Avg. time per rotation = 65.0 sec. at Facility 2 and 45.0 sec. at Fac. 4 (based on time recorded by the observer)

Blanket Wash 39

Composition:
Water
Hydrocarbons, petroleum distillates
Propylene glycol ethers
Alkanolamines
Ethylene glycol ethers

VOC Content: 37%; 2.9 lbs/gal
Flashpoint: 155°F
pH: 9.2

Facility 5

At Facility 5, Wash 39 was used on a single-unit 12" x 18" press, and a single-unit 12" x 18" press with conventional inks and print commercial products such as business cards and advertisements. The press operator at Facility 5 used Wash 39 for most jobs during the one-week demonstration. At this facility, each blanket is typically wiped down two times during cleaning: once with blanket wash to remove the ink, and once with a clean, dry shop towel to remove excess wash. Blanket wash is applied directly to the blanket using a squirt bottle and is then wiped off using a reusable shop towel. The same shop towel is used until it has too much ink build-up to effectively clean the blanket. This application procedure was modified for the baseline wash and substitute wash demonstrations by applying the wash first to the shop towel instead of directly to the blanket. Currently, this facility uses two blanket wash products. According to the MSDSs, one contains aliphatic hydrocarbons, cyclohexane, n-heptane, methylcyclohexane, toluene, C_6-C_8 paraffins, and C_6-C_8 cycloparaffins and the other consists of aromatic hydrocarbons, aliphatic hydrocarbons, 1,2,4-trimethylbenzene, xylene, dipropylene glycol methyl ether, and propylene glycol methyl ether. Facility 5 has tried a variety of substitute blanket washes donated by suppliers. None of these products were adopted either because they did not work as well as their standard wash (left an oily residue on the blanket) or they were too expensive (up to twice as much as their standard wash).

The press operator at Facility 5 evaluated Wash 39 as "good". Although Wash 39 did not dry as fast as the baseline wash, it was found to cut the ink well. The substitute wash was also observed to leave an oily residue on the blanket which required some extra effort to remove with a dry shop towel, but no effect was noticed on the print quality. Wash 39 was tested under light, medium and heavy ink coverage conditions, while the baseline wash was tested under light ink coverage conditions only. Under light coverage conditions, it was observed that Wash 39 required 2.7 rotations to clean the blankets and the baseline wash required 2.0 rotations. The level of physical effort needed to wash the blanket was rated as "medium" for both the substitute wash and the baseline wash. While Wash 39 was found to be effective on the blankets, according to the press operator it could not be used on the rollers. Two products were therefore required to clean up the press, increasing the time and effort needed.

Facility 8

Facility 8 used a 6-unit 20" x 26" press with conventional inks to print brochures, advertisements and other commercial products. The press operator at Facility 8 cleaned five blankets using Wash 39 and then stopped the demonstration because the substitute wash did not cut the ink well and required an unacceptable amount of effort to clean the blankets. At this facility, each blanket is typically wiped down two times during cleaning: once with a reusable shop towel saturated with blanket wash, and once with a clean dry shop towel to remove excess wash.

The saturated shop towel is typically used to clean all six blankets on the press before being resaturated or sent out for laundering. This application procedure was also used for the application of the baseline wash and the substitute wash. Facility 8 was using a wash which, according to the MSDS, contains aliphatic petroleum distillates, aromatic petroleum distillates, xylene, 2-butoxy ethanol, methylene chloride, diacetone alcohol, diisononyl phthalate, 2,6-di-tert-butyl-p-cresol, ethylbenzene and 1,2,4 trimethylbenzene to clean the blankets prior to and following the blanket wash demonstration. Alternative low-VOC blanket washes were experimented with in the past, but they did not cut the ink well, did not dry fast, and left and oily residue on the blanket.

Based on the five blanket cleanings with Wash 39, the press operator at Facility 8 evaluated the performance as "poor". The baseline wash was observed to perform well; cutting the ink well and drying quickly. The operator observed that Wash 39 did not cut the ink well and required a substantial amount of time and effort to get the blankets ready for printing. Wash 39 and the baseline wash were tested under medium ink coverage conditions only. Under these conditions, it was observed that the substitute wash required 6.0 rotations to clean the blanket and only 2.7 rotations using the baseline wash. Because Facility 8 took 17.7 seconds on average to rotate the blanket once, the average increase in blanket cleaning time was about one minute over that of the baseline. Additional time and effort were also needed because the thick consistency of Wash 39 made it difficult to get the wash to soak into the shop towel. The substitute wash left an oily residue on the blanket, but the residue was not observed to have an effect on the print quality. The press operator rated the effort needed to clean the blankets using Wash 39 as "high" primarily due to the extra steps needed to clean the blanket and the difficulty in getting the product to soak into the shop towel. The effort needed to use the baseline wash was also rated as "high" because the operator found it to have unusually high resistance when dragging it across the blanket.

Summary of Performance Demonstrations for Blanket Wash 39

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 39	2.9; 37%	155	4.8	0.6 @ 77°F	1.5	3	7	10
Baseline Wash	6.2; 100%	50	6.6	15 @ 100°F	1.5	3	3	8

Field Demonstration Results								
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 39 at Facility 5	0.7 ± 0.3 (n=32)[a]	2.7 ± 0.5	3.3 ± 0.4	4.2 ± 1.0	Medium	Medium	Medium	*Based on a sample size of 32 blanket washes:* • Good overall performance; cut ink well. • Did not dry as quickly as baseline wash and left an oily residue on the blanket. • Product did not work on rollers.
Baseline Wash at Facility 5	1.0 (n=1)	2.0 ± 0.0	NA	NA	Medium	NA	NA	• Good performance; cut ink well.
WASH 39 at Facility 8	1.0 ± 0.0 (n=5)	NA	6.0 ± 0.0	NA	NA	High	NA	*Based on a sample size of 5 blanket washes:* • Did not cut ink well and therefore required extra time and effort to clean blankets. • Difficult to get wash to soak into shop towel. • Left oily residue on blanket.
Baseline Wash at Facility 8	0.7 ± 0.0 (n=4)	NA	2.7 ± 0.5	NA	NA	High	NA	• Cut ink well. • Extra effort was required due to resistance to being dragged across the blanket.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = number of washes on which this data is based, as recorded by the printer.

[b] Time required to clean the blanket measured by the number of blanket rotations. Avg. time per rotation = 15.4 sec. at Facility 5 and 17.7 sec. at Facility 8 (based on time recorded by the observer)

Blanket Wash 40

Composition:
Hydrocarbons, aromatic
Hydrocarbons, petroleum distillates
Fatty acid derivatives
Ethoxylated nonylphenol

VOC Content: 52%; 3.8 lbs/gal
Flashpoint: 155°F
pH: 4.8

Facility 1

At Facility 1, performance demonstrations were conducted on an eight-unit, 28" x 40" press using vegetable-based inks to print high quality, multi-color, commercial products. Currently, Facility 1 uses a blanket wash which consists of aromatic hydrocarbons, 1,2,4-trimethylbenzene, and aliphatic hydrocarbons as their standard wash, according to the MSDS. In the months preceding the demonstrations, the facility had tried two different low-VOC blanket washes; neither worked as well as their standard wash. At this facility, each blanket is typically wiped down twice during cleaning: once with a reusable shop towel saturated in blanket wash to remove the ink, and once with a dry shop towel to remove excess blanket wash. Each saturated shop towel is used to clean two blankets. The same application procedure was used for the baseline and substitute products. The quantity of wash needed to saturate the shop towel and clean the blanket remained constant throughout the demonstration, regardless of the ink coverage or ink build-up on the blanket. There were both positive and negative aspects to this application method. While more wash than was needed may have been used in some cases, the consistency of the application volume made it possible to compare the performance of the standard, baseline, and substitute products under the same conditions.

Overall, the performance of Wash 40 was considered "good" when ink coverage was medium, and "good/fair" for heavy ink coverage; no information was recorded on the performance of Wash 40 on a blanket with light ink coverage. The facility used Wash 40 for one week, but recorded information on only 6 washes. The press operator who usually completed the forms was out of the facility for several days, during which time forms were not completed although the product was used. Following the manufacturer's instructions, Facility 1 diluted one part wash with one part water. When used at the diluted concentration, Wash 40 left a greasy residue on the blanket. It usually took two rotations of the blanket while wiping with a dry shop towel to remove this residue. Because of this extra effort, the press operator stopped diluting the wash and tried using it at full strength. At full strength, residue was no longer a problem. Blankets with medium ink coverage on average required one rotation to clean, one rotation to dry, and low effort. When the ink coverage was heavy, the effort increased and three or four rotations and medium effort were needed to clean the blanket. The performance of Wash 40 was comparable to the baseline wash performance. The operator found the baseline wash cut the ink well, but required slightly more effort than their standard wash. As with Wash 40, two blanket rotations were needed to clean the blanket when ink coverage was light or medium; the baseline was not used on a blanket with heavy ink coverage. Since blanket rotation is automatic, each rotation consistently took 20 seconds, resulting in an average cleaning time when using Wash 40 of 40 seconds (2 rotations) for medium ink coverage, and 80 seconds (4 rotations) for heavy ink coverage. The press operator found that Wash 40 was easier to apply when the blanket was wiped with a sponge wet with water prior to application of the blanket wash. In this facility's standard practice, a wet sponge is occasionally used to wipe any paper or particles from the blanket before applying a blanket wash, so this extra

step was not seen as particularly burdensome. At all levels of ink coverage, no print quality problems attributable to Wash 40 were experienced.

Facility 10

At Facility 10, Wash 40 was demonstrated on a six-unit, 19" x 28" press using conventional inks to print primarily commercial products, such as brochures, cards, and posters. Currently, Facility 10 uses a naphtha blend as their standard wash, according to the MSDS. They have tried a few alternative washes, but found that they either did not work as well, or that they cost more than twice as much as their standard blanket wash. Typically, this facility uses the following procedure to clean the blanket: wipe the blanket with a water-soaked sponge to remove built up paper and particles (1 - 2 rotations); pour blanket wash onto a reusable shop towel from a squeeze bottle; wipe blanket with product (2 rotations); wipe off excess with a clean, dry shop towel (1 - 2 rotations). Both the baseline product and Wash 40 were applied using the same procedure.

Facility 10 used Wash 40 for one week, recording data for 20 blankets, and the performance was evaluated as "good" Although the manufacturer's instructions indicated that Wash 40 could be diluted with up to 50 percent water, the press operator preferred to try it at full strength first, and if successful, he would dilute the product. At full strength, the wash cut the ink well. Only one blanket with heavy ink coverage was cleaned with Wash 40 during the demonstrations. On this blanket with heavy coverage, the operator found some extra effort was required (4 blanket rotations instead of the 3 rotations required for light and medium coverage, and medium effort instead of the low effort reported for light and medium coverage). Because of this additional effort for heavy ink coverage, the printer felt that the diluted wash would not perform well and he only used Wash 40 at full strength. He did, however, pour the wash onto a shop towel that was slightly dampened with water, instead of a dry shop towel. According to the press operator, the performance of Wash 40 was comparable to the performance of the baseline wash. The operator found the baseline product worked as well, with the same effort required and ability to cut the heavy ink coverage as their standard product, but the odor was strong. There were no problems with print quality attributable to the wash, and there was no odor noticed when using this blanket wash.

Summary of Performance Demonstrations for Blanket Wash 40

Laboratory Testing Results								
Product	**VOC Content (lbs/gal; % by wt)**	**Flashpoint (°F)**	**pH**	**Vapor Pressure (reported, mm Hg)**	**Blanket Swell (%)**		**Washability (# strokes)**	
					1 hour	***5 hour***	***Wet Ink***	***Dry Ink***
WASH 40	3.8; 52%	155	4.8	4.7 @ 77°F	1.5	3	5	10
Baseline Wash	6.2; 100%	50	6.6	15 @ 100°F	1.5	3	3	8

Field Demonstration Results							
Product/ Facility	**Average Volume Used (ounces)**	**Time required[b] (# rotations)**			**Physical Effort Required (Low, Medium, or High)**			**Performance Evaluation**
		Light Coverage	*Medium Coverage*	*Heavy Coverage*	*Light Coverage*	*Medium Coverage*	*Heavy Coverage*	
WASH 40 at Facility 1	2.5 ± 0.0 (n=6)[a]	NA	2.0 ± 0.0	3.7 ± 0.6	NA	Low	Medium	*Based on a sample size of 6 blanket washes:* • Good performance. • When diluted with water, left residue. No residue problem at full strength.
Baseline Wash at Facility 1	2.5 ± 0.0 (n=2)	2.0 ± 0.0	2.0 ± 0.0	NA	High	High	NA	• Good performance. • Required slightly more effort than standard wash to remove the excess wash.
WASH 40 at Facility 10	0.9 ± 0.2 (n=20)	3.0 ± 0.0	3.0 ± 0.0	4.0 ± 0.0	Low	Medium	Medium	*Based on a sample size of 20 blanket washes:* • Good performance; cut ink well. • Required slightly more effort when coverage was heavy.
Baseline Wash at Facility 10	1.5 ± 0.0 (n=2)	NA	NA	5.0 ± 0.0	NA	NA	Medium	• Good performance; cut heavy ink well. • Operator noticed a strong odor.

NA = Not Applicable; product was not demonstrated under these conditions.

[a] n = number of washes on which this data is based, as recorded by the printer.

[b] Time required to clean the blanket measured by the number of blanket rotations: Avg. time per rotation = 20.0 sec at Facility 1 and 11.2 sec at Facility 10 (as measured by the observer)